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THE SOLUBILITY OF GOLD IN CYANIDE SOLUTIONS.*

By H. A. White (Member of Council).

Very little research on this subject has been published since Prof. Christy's papers (Trans. *Am. Inst. Min. Eng.*, 1895), and the two papers by Maclaurin (*Jour. Chem. Soc.*, Vols. 57 and 58), though Julian and Smart in their work, "Cyaniding Gold and Silver Ores" (London, 1904) publish some sets of figures which are obviously derived entirely from measurements of current generated in cells, of which gold forms one of the electrodes, and have little relation to actual practice where the conditions must be regulated by the last particles of gold which it is profitable to dissolve.

Maclaurin's figures deal with plates of fairly pure gold and doubtfully pure potassium cyanide, and were carried out with great skill and elaborate precautions. He does not however express his results in figures which show loss of gold for a definite area exposed, nor does he measure the oxygen contents of his solutions, nor even the cyanide strength both before and after the experiments.

The principle object of the experiments detailed below is to give as much guidance as possible in actual gold extraction and to show the results obtained in a form which shall be available as a basis for more elaborate research. Time and facilities were not available for strict regulation of conditions, nor for the frequent repetition of experiments which are called for by difficulty of securing stable surface conditions where the interaction of solids and fluids is under investigation. The complete examination of this subject in all its branches would form splendid material for a research which might occupy a suitably equipped laboratory for some years, and this is more likely to be undertaken by government, or by some modern university, as the results will not very probably materially increase the extraction of gold or the cost thereof.

A subsequent paper will deal with the allied subject of the solubility of zinc, but attention is here called to the remarkable fact that though zinc easily replaces the gold from aurocyanide solutions yet the rate of solution of gold by cyanide solution is five to six times as rapid as that of zinc. Maclaurin found the relative rates of solution of gold and silver to be proportional to their atomic weights, and the same is true for zinc if relative equivalents be substituted.

Thus, $2\mathrm{Au}/\mathrm{Zn} = 394{\cdot}4/65{\cdot}37 = 6{\cdot}03$.

The experimental results strongly suggest that the speed of the reaction entirely depends upon the rate of diffusion of the cyanide and the necessary oxygen of which in practice the latter is the more important. The final effect of the reaction is given by the well-known equation:—

$$2\mathrm{Au} + 4\mathrm{KCy} + \mathrm{O} + \mathrm{H_2O} = 2\mathrm{KAuCy_2} + 2\mathrm{KHO}$$

$$\begin{array}{lll} 394{\cdot}4 : & 260{\cdot}44 : & 16{\cdot}0 \\ 1{\cdot}000 : & 0{\cdot}6603 : & 0{\cdot}04057 \\ 1{\cdot}5145 : & 1{\cdot}000 : & 0{\cdot}06144 \\ 24{\cdot}648 : & 16{\cdot}276 : & 1{\cdot}000 \end{array}$$

Therefore 10 mgm. oxygen per litre is equivalent to 0·0163% KCy; 7 mgm. oxygen per litre is equivalent to 0·0114% KCy; 6 mgm. oxygen per litre is equivalent to 0·0098% KCy.

An average figure for oxygen concentration in this district may be taken at 6 mgm. per litre, and other things being equal it is not obvious that there should be any advantage in maintaining the cyanide strength in working solutions much in excess of 0·01%.

---

*This paper will be submitted for Discussion at the Ordinary General Meeting on the 20th September.

Now Maclaurin found a maximum speed of reaction at 0·25 % KCy, though his curve is certainly very flat at this point and his oxygen content was possibly in the neighbourhood of 10 mgm. per litre, while apparently no note was taken of any loss of cyanide during the experiment. Allowing for this and putting the rate of diffusion of oxygen at three times the rate for potassium cyanide, it is difficult to see why any gain can be made in increasing the cyanide strength beyond 0·05 %, as the formation of H_2O_2 in accordance with Bödlander's reaction would work in the opposite direction. Experiments were especially directed towards clearing up the anomaly thus revealed, and in the neighbourhood of 6 mgm. of oxygen per litre it was found that the greatest speed of reaction was between 0·020 and 0·030 % KCy, Sodium cyanide of equivalent strength actually being used. This is only one-tenth the strength found by Maclaurin, but it is confirmed by the fact that a similar point is found for the solution of zinc and also for the solution of either pure gold or battery bullion in solution made up with sodium zinc cyanide ("total" cyanide strength being taken.)

This suggests that no advantage can be obtained by using greater cyanide strength than 0·025 % either for the solution of gold or for improving the "action" in extractor boxes. However, upon re-arranging sand treatment upon this principle for the last nine months I have found very little effect upon either extraction or cyanide consumption but some little improvement in precipitation while "last drainings" have been reduced from 0·250 dwt. to 0·157 dwt., upon an average of nine months' work for each method. The diagram of course of treatment in the two cases clearly reveals the fact that in practice the 0·025 % KCy has more rapid action on the gold than the 0·05 % solution, which is actually present when 0·10 % "strong" solution is pumped on as usual, and I think that a consideration of all such diagrams will suggest that this is usually the case.

If 0·028 % KCy is the most effective, as a comparison of all the experiments detailed indicates, this would imply that oxygen diffuses at three times the rate of sodium cyanide, but a few rough experiments on this point indicate a less speed than that of NaHO. Accurate experiments upon this point are much to be desired. At such strengths and in presence of the usual alkalinity (roughly equivalent to the NaCy present), the variation in ionisation of the cyanide or the loss by hydrolysis to nonionised HCy could have very little bearing on the problem. The above holds good only for plates of gold or bullion freely suspended below the level of the liquid, and very different results are found for floating gold leaf, or when the gold is in contact with such conductors as iron or carbon.

The most effective strength when gold leaf is floated on the solution is shown to be about 6 % KCy. At this very high figure the reaction is very rapid, and even the presence of a double layer of oxygen molecules upon each surface involved could hardly explain the difference found. I do not yet see however how this effect could be utilised in practice, though the advantage of draining dry after each wash of solution is rendered more obvious.

Experimental.—The results are generally expressed in milligrams per square centimetre of exposed surface per 24 hours. The gold was carefully purified in the usual manner, and compared favourably with the check gold supplied for bullion assay purposes. It was rolled down to about 0·1 mm. thickness and cut into rectangles 1½ × 1 cm. and therefore exposed 3 sq. cm. to the solution, it was annealed in all cases before use at low red heat. The battery bullion employed was especially purified by remelting with nitre, and contained 113 parts of silver and 17 parts of base metal per 1,000 —the aim being to reproduce as nearly as possible the actual metal as it is found in the ore

The gold leaf was the usual commercial article and was assumed to be 1/280,000 inch thick.

The zinc used was ordinary commercial sheet zinc rolled down to about 0·3 mm. thickness, and cut into rectangles 2·5 × 1·5 cm., and exposed 7·5 sq. cm. of surface to the solution

The cyanide employed was selected from newly opened cases of sodium cyanide (130 % KCy), and freed from sulphur by addition of slight excess of lead nitrate, then filtered and aerated.

Temperature was taken before and after each experiment, but no attempt was made to hold it constant though care was taken to have exposures identical in each series, even as regards lighting of the gold surfaces.

The apparatus usually employed was a series of 500 cc. jars, kept away from contamination by acid fumes, etc. The exposure to solution was usually less than 24 hours, and in each case the total and free cyanide, alkalinity as NaHO, and the oxygen content of each solution was determined both before and after the experiments (the average only being quoted). The gold was weighed on a sensitive balance after careful drying. The gold was usually suspended by cotton thread about half an inch below solution level, except where contact with steel or carbon was employed, when the gold was allowed to rest upon the carbon lying on the bottom of the vessel. The carbon employed was carefully cleaned arc lamp carbon, 15 mm. diameter pierced with five holes of 3 mm. diameter. The two lengths of 8·5 cm. each, usually employed thus exposed 160 sq. cm. of surface.

Where air was bubbled through solutions, compressed air, freed from carbon dioxide by means of sodium hydrate was passed through glass tubes with very fine openings, and the air was not allowed to impinge directly upon the gold. In the experiments where reduced oxygen was used stoppered 300 cc. glass bottles were used with a specially shaped glass rod introduced from which to suspend the gold plate by means of cotton.

In certain very dilute solutions a brownish red stain appeared upon the gold plates, and this was determined to be aurous cyanide which indicates the possibility that in certain cases the rate of solution of aurous cyanide in sodium cyanide or the diffusion of the product may be a determining factor in the speed of reaction. If copper foil be substituted for gold plate a white stain of cuprous cyanide may similarly be obtained. (Compare brown stain reported on gold (Vol. VI., *C.M.M.S. Journal*, p. 110), when gold is acted upon by ferric thiocyanate).

A microscopic examination of the surface of the gold indicates that the action is not very regular, and in some cases a hole may be eaten right through the metal.

Experiments with Gold Leaf.—Gold leaf 1/280,000 in. thick would weigh 0·175 mgm. per sq. cm. of surface exposed while floating on solution, or half that amount when sunk below the surface.

(1) Solution entering slime boxes, KCy 0·010% (free) NaHO 0·008. Temperature 29·5 C. Oxygen 6 mgm. per litre.

Gold leaf floating goes in 90 minutes = 2·8 mgm. per sq. cm. in 24 hours.

Gold leaf sunk goes in 120 minutes = 1·0 mgm per sq. cm. in 24 hours.

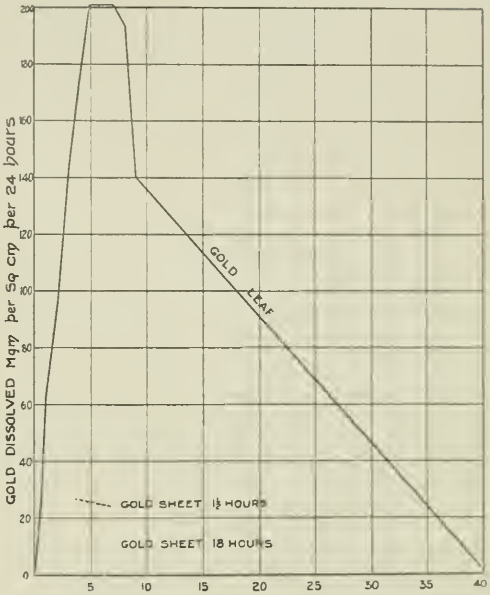

Fig. I.—Per cent KCy. Rate of Solution of Gold floated on Cyanide Solutions.

(2) Solution made up from stock at 48% KCy, NaHO 1·08%.

Temp. C.	KCy. per cent.	First Hole min.	Finish.	Mgm. per sq. cm. per 24 hrs.	Sunk Finish. min.	Mgm. per sq. cm. per 24 hrs.
30·5	0·0186	24	70	3·6	120	1·0
30·5	0·0209	17	51	4·9	38	3·3
30·5	0·0233	13	48	5·2	37	3·4
30·5	0·0256	12	49	5·1	37	3·4
30·5	0·0279	14	54	4·7	37	3·4
30·5	0·233	8	25	10·1		
31	0·583	3	11	22·9		
26	1·00	1·7	4·0	63·0		
26	2·00	1.1	2.3	94·5		
26	3·00	1.0	1.7	144·0		
26	4·00	0.9	1.4	178·0		
26	5·00	0.8	1.2	201·0		
26	6·00	0.7	1.2	201·0		
26	7·00	0.7	1.2	201·0		
26	8·00	0·5	1·3	194·0		
26	9·00	0·5	1·8	140·0		
26	10·00	0·7	1·8	137·0		
31	48·00	31	80	3·4		

Gold leaf sunk in 10% KCy took more than 4 hours to dissolve, while the floating leaf took less than 2 minutes.

(3) Gold sheet about 0·1 mm. thick floated on solution exposing 1·5 sq. cm. of surface to solution. Rate given is expressed in mgm per sq. cm. per 24 hours.

Temp. C.	KCy.	NaHO.	Time Exposed Hours.	Rate of Solution.
28.5	7.00	0.32	18	11.6
20.5	7.00	0.32	1.5	22.1
20.5	7.00	0.32	0.5	24.0
20.5	3.50	0.16	1.5	27.2
20.5	3.50	0.16	0.5	26.9

Remarks.—The slackening of the rate of solution with time suggests that the surface of the solution contains excess oxygen which is gradually used up, but the very great rate of action with floating gold leaf would make it appear that it offered little obstacle to the diffusion of oxygen from the air. Even the oxygen required by equation to balance 6% KCy would be 3,711 mgm. per litre, and in the air itself the concentration did not amount to 250 mgm. per litre.

Experiments with Fine Gold Plates.—

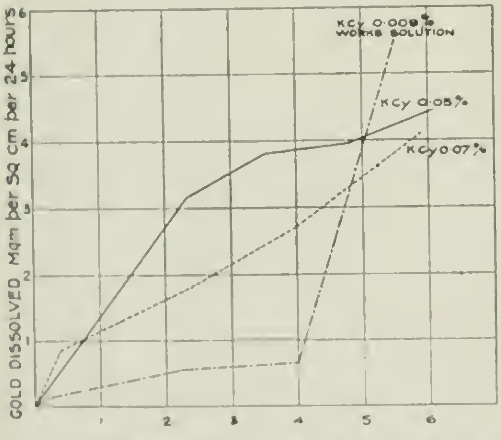

FIG. II.—Oxygen mgm per litre. Influence of Oxygen Concentration upon Gold Solution.

(1) Influence of oxygen concentration
(a) On works solutions.
(b) On synthetic solution.

(a) Works solution of varying oxygen content was made up by mixing solution leaving slime boxes, with 0·5 mgm and the same solution after aeration to 7·0 mgm per litre. Stoppered 300 cc bottles were used. The average of the oxygen content (in mgm. per litre) is given as determined before and after the experiments in all cases.

Temp. O.	KCy. Free.	KCy. Tot.	NaHO	Oxygen. m.p.l.	Gold Dissolved. (mgm.-24 hrs.) per sq. m.
21-21	0.009	0.010	0.008	5.5	5.49
21-21	0.009	0.010	0.008	4.0	0.63
21-21	0.009	0.010	0.008	2.25	0.56
21-21	0.009	0.010	0.008	0.25	0.12

The importance of thorough aeration of works solution is thus very marked, but the influence on synthetic solutions of higher cyanide content though certain is not nearly as effective. In many cases where it could be determined the loss of oxygen corresponded closely with the gold dissolved in accordance with Elsner's equation above.

(b) Synthetic solutions were deprived of oxygen by boiling (the 0·05% KCy) for 5 minutes, and cooling rapidly when 3·0 mgm. still remained, or by passing purified hydrogen through (the 0·07% KCy) till oxygen remaining was reduced to 0·5 mgm. Mixtures with aerated solution were then made.

Temp C	KCy.	Oxygen. m.p.l.	Gold. mgm. per sq cm. per 24 hours
19-14	0·05 %	6·1	4·5
19-14	0·05	4·8	4·0
19-14	0·05	3·5	3·8
19-14	0·05	2·4	3·1
19-19	0·072	5·9	4·1
19-19	0·072	4·0	2·8
19-19	0·072	2·4	1·8
19-19	0·072	0·5	0·8

Experiments were made to determine the effect of the oxygen absorbers present in working solution, but with sodium sulphite and thiosulphate it was found that the

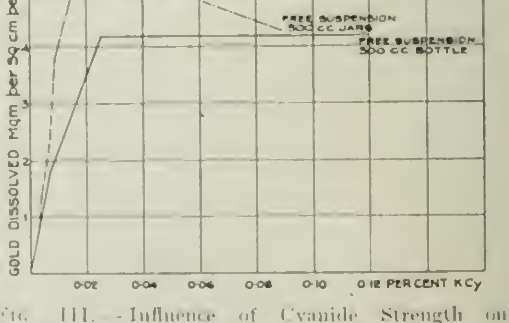

FIG. III.—Influence of Cyanide Strength on Solution of Gold. NaCy used. Not Air Bubbled.

former must be present in synthetic solutions to the extent of 0·010% before injurious effects were obvious, while the latter had no bad effect up to 0·05%. Ordinary working solutions are not likely to contain so much of either.

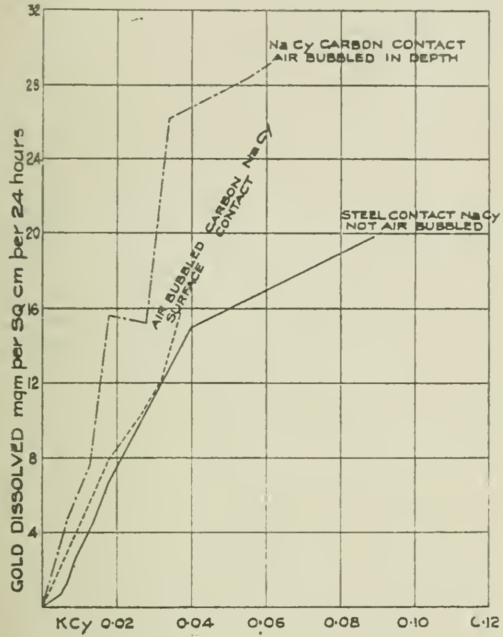

Fig. IX.—Total KCy Equivalent Percentage: Influence of Electrolytic Contact on Gold Solutions.

(5) Influence of cyanide concentration

(a) Free suspension and no air bubbling.

(b) Free suspension and steel contact no air bubbling.

(a) Free suspension in loosely covered 300 cc. bottle.

Temp. C.	KCy.	Oxygen. m.p.l.	Gold Dissolved. mgm. per. sq. cm. per 24 hours.
17–19	0·120	5·2	4·2
17–19	0·023	5·2	4·2
17–19	0·007	5·2	1·8

(b) One piece of gold was freely suspended in 3 in., 500 cc. glass jars, and a second piece in each jar was placed in contact with two steel plates of total surface 36 sq. cm. Temperature at start 19 C., and at finish, 22 hours later, 23·5 C.

KCy.	Oxygen. m.p.l.	Gold Dissolved. mgm. per sq. cm. per 24 hr.	
		Free Suspension.	Steel Contact.
0·089	5·2	4·3	19·8
0·040	5·7	5·2	15·1
0·018	5·5	5·4	6·7
0·014	5·5	4·8	4·4
0·009	5·5	3·8	2·5
0·007	5·5	2·4	1·3
0·005	5·2	1·8	0·7
0·004	5·2	1·4	0·5
0·003	4·7	0·8	0·02
0·0015	4·7	0·03	0·002

The alkalinity varied in accordance with cyanide strength from 0·010% to 0·001% NaHO, the steel was rusted at strengths 0·018% KCy downwards, and solutions became more and more yellow and cloudy from 0·009% KCy down.

No advantage in contact with steel is apparent at low strengths of cyanide, and it is evidently advisable to remove finely divided iron where low strength of cyanide solution is employed. In all cases the loss of cyanide was much greater than corresponded with gold dissolved and in the weaker solution, in spite of the free air surface more oxygen was consumed than accounted for by the gold. In this way two of the disadvantages of the presence of fine iron were illustrated.

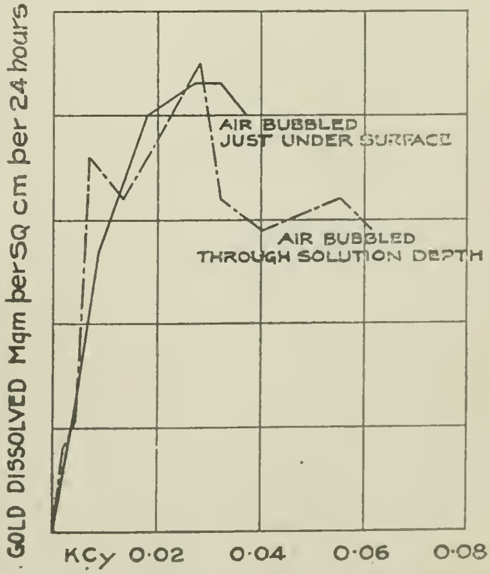

Fig. IV.—Influence of Cyanide Strength on Solution of Gold. NaCy used. Air bubbled freely. Gold freely suspended.

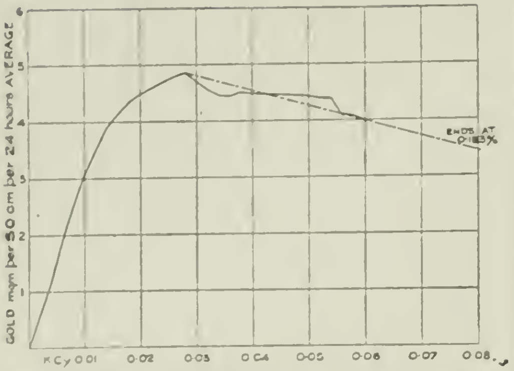

FIG. VIII. Total KCy equivalent Percentage. Averages of all experiments on action of Cyanide Solutions on freely suspended Gold or Bullion.

(6) Varying cyanide:
- (a) Air bubbled through solution near surface.
- (b) Air bubbled through entire depth of solution.

(a) Air bubbled through just under surface with fine glass tubing. One piece of gold freely suspended and another piece rested across two carbon rods of total surface 160 sq. cm. 500 cc. solution in 3 in. glass jars open to air at surface. Temperature 19—23·5 C.

KCy.	NaHO.	Oxygen. m.p.l.	Gold Dissolved. mgm. per sq. cm. per 24 hr.	
			Free Suspension.	Carbon Contact.
0·037	0·0019	2·7	4·0	15·8
0·032	0·0008	3·2	4·3	12·1
0·027	0·0007	3·2	4·3	10·4
0·018	0·0011	3·5	4·0	7·9
0·009	0·0009	3·0	2·7	3·9
0·004	0·0005	2·7	1·2	1·9

As distilled water was used for this with low alkalinity the air was blown through a strong solution of NaCy in addition to the usual NaHO and little cyanide was lost beyond that combined with the gold.

(b) Air bubbled through glass tube drawn out to a fine point, and playing on the carbon rods at bottom of tube. One piece of gold free and one piece bound across two carbon rods, total surface 160 sq. cm. 400 cc. solution in 500 cc. glass jars 3 in. diameter open to air Temperature 25—14 C.

It is evident that contact with carbon increases the rate of gold dissolution in every case, but though attempts have been made before to utilise this fact they have not been successful.

KCy.	NaHO.	Oxygen. m.p.l.	Gold Dissolved. mgm. per sq. cm. per 24 hr.	
			Free Suspension.	Carbon Contact.
0·061	0·0056	5·5	2·9	29·2
0·055	0·0045	5·5	3·2	28·4
0·040	0·0053	5·2	2·9	42·0
0·034	0·0046	5·2	3·2	26·2
0·028	0·0051	5·2	4·5	15·1
0·018	0·0026	5·2	3·6	15·6
0·013	0·0012	5·5	3·2	7·5
0·0065	0·0092	5·5	3·6	4·6
0·0040	0·0003	6·5	1·1	1·2
0·0020	0·0044	6·5	0·8	0·9

(7) Using Na_2ZnCy_4 solution prepared from 11% NaCy by addition of zinc sulphate and filtering off precipitate. Dilution was done with Rand Water Board water.

- (a) With plates of fine gold.
- (b) With plates of battery bullion.

(a) With fine gold plates. 500 cc. solution used in 3 in. open glass jars but no air bubbled through. The jars were kept in

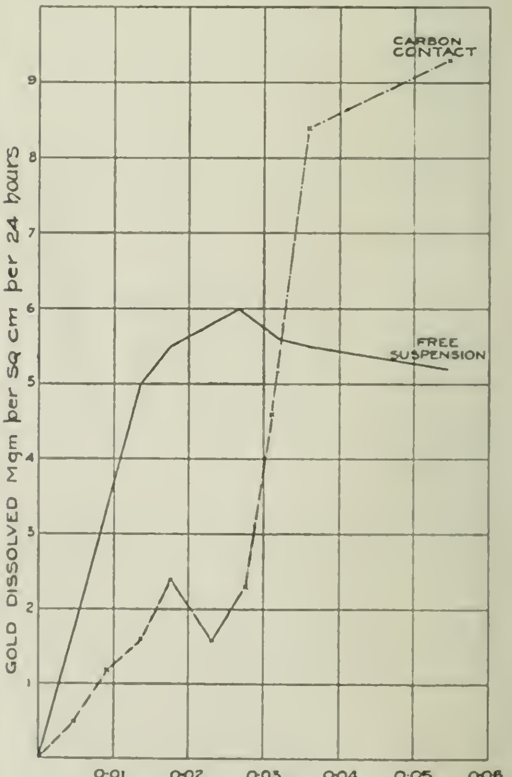

FIG. V.—Influence of Cyanide Strength upon Solution of Gold. Na_2ZnCy_4 used. No air bubbled through.

the *dark.* Temperature 25—18 C. 16 hours contact, one plate free and one with carbon, as in (6).

KCy Total.	NaHO.	Oxygen. m.p l.	Gold Dissolved. mgm. per sq. cm. per 24hr.	
			Free	Carbon Contact.
0·0545	0·0052	6·2	5·2	9·3
0·0360	0·0038	6·5	5·5	8·4
0·0320	0·0038	6·5	5·6	4·6
0·0275	0·0046	6·2	6·0	2·3
0·0230	0·0044	6·2	5·8	1·6
0·0175	0·0042	6·2	5·5	2·4
0·0135	0·0042	6·2	5·0	1·6
0·0090	0·0040	6·5	1·8	1·2
0·0045	0·0042	6·5	1·7	0·5

Some fine threads of $ZnCy_2$ were observed hanging from the gold plates. Only total cyanide determination averages are given, as the free cyanide test was uncertain and not very different from the total. The loss of cyanide between beginning and end of experiments in many cases corresponded closely with the gold dissolved.

It will be noticed that the freely suspended gold is even more soluble than in free cyanide of same total strength, partly due to high oxygen contents of solutions. Carbon contact is only helpful above 0·032% KCy strength, and is very disadvantageous at low strengths, in fact there is obviously less action where the gold actually touches the rods.

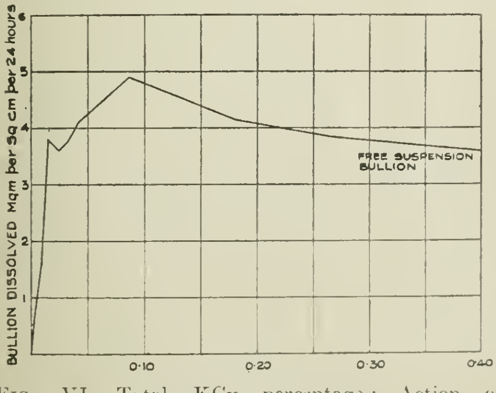

Fig. VI.—Total KCy percentage: Action of Na_2ZnCy_4 Solutions on Battery Bullion.

(b) With battery bullion plates. Conditions as in 7 (a), except that light was not completely excluded. Temperature 27—17 C. Contact 16 hours.

The bullion plates were almost black from exposed base metal where much gold had been dissolved.

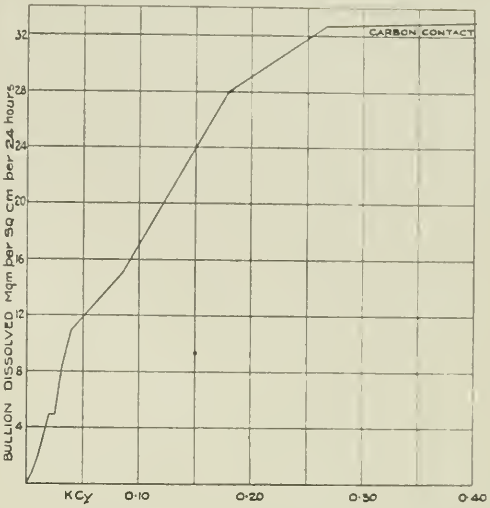

Fig. VII.—Total KCy equivalent Percentage: Action of Na_2ZnCy_4 Solution on Battery Bullion.

KCy Total	NaHO	Oxygen m.p l.	Bullion Dissolvel. mgm. per sq. cm. per 24 hr.	
			Free.	Carbon Contact.
0·444	0·0226	4·2	3·5	32·9
0·268	0·0169	4·2	3·8	32·7
0·181	0·0150	4·5	4·1	28·0
0·086	0·0107	4·5	4·9	15·1
0·042	0·0083	4·5	4·1	10·9
0·033	0·0076	4·7	3·8	8·4
0·026	0·0072	4·7	3·6	4·9
0·021	0·0070	4·7	3·8	4·9
0·009	0·0060	5·0	1·6	1·9
0·004	0·0056	5·2	0·5	0·8

The different effect of carbon contact with bullion plates compared with fine gold plates is extraordinary, and compares with the effect found when pure cyanide solutions are used instead of solutions saturated with zinc as in above experiments. The low oxygen accounts for small solution of gold in the freely suspended plates, yet curiously the maximum effect appears to be found at a higher strength of total cyanide.

Discussion of Results.—The experiments strongly indicate a maximum action of cyanide solutions upon gold, when free from electrolytic contact between 0·02% and 0·03% KCy, and there seems no adequate reason for maintaining higher strengths in contact with sand under treatment, where the last portions to yield a profit have chiefly to be considered, and these may well be assumed to be in contact with quartz only. Adequate oxygen concentration is always of advantage, and especially in case of working solutions where side reactions are effective competitors for the oxygen present.

If the most effective rate for solution of gold bullion in cyanide solution be put at 4 mgm. per sq. cm. per 24 hours, and the greatest speed observed in practice on low grade ores is put at 10 dwt. per ton per 24 hours, this would show:—

At sp. gr. 17·0, 1 mgm. per sq. cm. = 0·000081 in. thick = 0·01672 dwt. per sq. in.

And if 10 dwt. be dissolved in 24 hours there must be 600 sq. in. of gold surface available per ton of ore, also 10 million particles exposing surface of 1/100 × 1/100 in. would be required. If the ore were crushed to pass 1/100 in., one particle in every 400 would have a small speck of gold attached in order to fulfil the conditions outlined.

CHEMICAL ENGINEERING.

By J. A. Wilkinson, M.A., F.C.S.
(Past-President).

(*Printed in Journal, March, 1919.*)

DISCUSSION.

Mr. A. McArthur Johnston (*Past-President*): I read with much pleasure the paper presented to this Society by Professor Wilkinson on the training of an engineering chemist. He has dealt very exhaustively with the matter and outlined carefully the necessary training to give a youth the main essentials for a successful career as such. I welcome the scheme the more heartily as I am convinced that until some such intermediary between the engineer and the chemist has been evolved and firmly established, the industrial life of each and every country must continue to suffer.

In the past the engineer has not been able to avail himself to the fullest extent of the knowledge and of the assistance of the chemist, whilst engineering methods have not been utilised to the highest degree owing to the lack of such engineering skill in the chemist as would be necessary to successfully carry out chemical details. It is true the works chemist has filled the bill to a small extent, but too often control has not been centred in him, and he has been looked upon as a faddist—perhaps not illogically—and suggestions from him have not been encouraged.

We know well the old saying that "One swallow does not make a summer," and it seems to me that Professor Wilkinson's scheme is inclined to be idealistic, and its result might be to create a profession reserved for the few. It would have given me greater pleasure to have had placed before us even outlines of a prospectus designed to reach the mass of engineering students. It is well known that evening class students far outnumber day students, and we would be wise if we recognised the value of educating these youths in such chemical knowledge as would assist them in their work and help them to realise the value of the skilled specialist, if I may designate Prof. Wilkinson's product as such.

From personal experience I know that the engineer who most appreciates the work of the chemist is the one who has some theoretical, or it may be practical, knowledge of chemistry—the engineer ignorant of this branch is generally chary of consulting the chemist. He is inclined to look on the chemist as a man to be avoided, if not as an actual enemy. He prefers to trust old time methods and listen to "quack" advice rather than show his lack of chemical knowledge. Before, therefore, we can essentially advance the nation's welfare in chemical industries, it seems to me that we must educate in chemistry the general mass of engineering students. To outline an educational scheme to cover any of the branches included in such I would not presume, but would prefer to leave this to the abler pen and readier speech of Prof. Wilkinson. If, however, I may be allowed to criticise his general scheme, which is, I take it, typical of present-day collegiate practice, I would say that too much time is devoted to general principles and too little—usually curtailed because the student has passed beyond the reach of the professor—to specialized subjects. The wants of the student in any particular branch of engineering in which he is engaged should be catered for as much as possible. A very considerable advance in engineering chemistry would be attained were it necessary for engineers on our mines to possess some chemical knowledge, and were it compulsory that the examination for granting certificates should contain a paper on engineering chemistry, the questions to deal mainly with problems likely to be encountered in their work.

Review.

Practical Instructions in the search for, and the determination of, the useful minerals, including the rare ores. New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd. Second edition, greatly enlarged. By Alexander McLeod. Price, 8/6 nett.

It is the avowed aim of this little handbook to furnish simple, but fully reliable, means by which any one can determine the useful minerals without much special training. Little apparatus is needed and but few and easily obtained chemicals are required to make the tests given. While the volume is for the most part based on the author's own experience, Dana's Mineralogy and other well known works are largely drawn upon so that little novelty of method is to be expected. A chapter on secondary enrichment of ores is added as a knowledge of the principal features must be useful to the prospector.

The printing is large and clear and the tables well arranged, though an obvious improvement would be to add the formulæ under the heading of composition in the main tables. The notes, such as "more than twice heavier than quartz," under the heading gravity, might well be omitted entirely, as the specific gravity, which has a meaning, is always given. Misprints are far from uncommon, and some careless phraseology may be found, such as the statement, p. xxl, that *molybdenite* and sulphur combine in the ratio 96 of *molybdenite* and 64 parts of sulphur. As an instance of the misprints may be quoted "nucaceous hemalite" on p. 251, for micaceous hematite, and on p. 236 "silicate glucium" is given as composition of beryl. "Fluorid" and "aluminum" are so spelled, and lead is referred to as "minimum" on page 38.

H. A. W.

Notices and Abstracts of Articles and Papers.

CHEMISTRY.

Tar Oil in Diesel Engines.—"Almost all heavy tar distillates are suitable for use in Diesel engines. The gross heat value of tar oils of British origin averages 10·2% less than that of the petroleum oils sold in this country, but the increase in consumption is not higher by this amount for the reasons that tar oil generally yields a higher thermal efficiency than petroleum oil (probably due to its lower viscosity), and owing to the average hydrogen content of tar oil being only about 6·9%, as against about 11·5% for petroleum oils, the difference between gross and net calorific values is not so great as with petroleum oils. The average ignition point of tar oils is about 480° C. as against 260° C. for petroleum oils, and it is this difference which is responsible for the troubles in obtaining ignition of tar oils. With a normal tar oil, petroleum is necessary for starting with compressions below 670 lb. per sq. in., but good running is obtained at over three-quarter load with a compression of 460 lb. per sq. in. Shale oil is particularly serviceable as an ignition oil with pilot ignition gear on account of its low ignition point. High temperatures of the circulating water help the combustion of tar oil to a small extent. Heating the cycle air lessens output of the engine by rarefying the air, but aids the combustion of tar oils. Advancing the fuel valve is a distinct advantage. The best results have been obtained with 9° advance when burning tar oil alone, and about 5° advance when using pilot ignition gear (running engine at 250 rev.). Mixing oils is of doubtful advantage, as it is necessary to employ more than half petroleum to obtain moderately good results, even when oils are such as will stand mixing without forming deposits. Hot blast is by far the most helpful modification for burning tar oil, but is rather dangerous, as it might cause explosions in the fuel valve casing. The fuel valve face suffers a little more with hot blast than in normal practice. Heating the fuel is useful from the point of view of increasing efficiency by reducing viscosity and as a means of dissolving naphthalene. Improved running on tar oil at low loads is obtainable by restricting the flame plate, but this is only at the expense of the full load results. Wear on exhaust valve is not very serious with tar oils, but is a much more important matter when burning raw tars. It only becomes serious when firing is uncertain, and is generally much worse when running on tar oil alone than with the pilot ignition system. Oils which give an abrasive ash on ignition may cause trouble even when this amounts to less than 0·08%, but when the ash consists largely of sodium sulphate (arising from washing tar acids from creosote), much higher ash contents are permissible. Tar oils containing pitch cause many troubles, but it is almost entirely the free carbon which affects the use of such mixtures in internal combustion engines."—H. Moore, Diesel Engine Users' Assocn., May 26, 1918 [Reprint], 24 pages.—*Journal of the Society of Chemical Industry*, Oct. 15, 1918, p. 572a. (J. A. W.)

Determination of the Ash of Coal.—"Incineration in a muffle-furnace does not always give the same result in the determination of the ash of coal as is obtained when the sample is ignited over a Bunsen burner; the latter method always gives a higher result when the coal contains much calcium carbonate, since this is not decomposed completely and at the same time sulphur compounds are absorbed from the products of combustion of the gas. If a muffle-furnace is not available, the coal should be ignited over a spirit flame or in an electric furnace. For commercial purposes, it is desirable that the method of determining the ash of coal and the temperature employed should be prescribed."—H. Mastbaum, *Chem.-Zeit.*, 1918, 42, 385-386, 391-392.—*Journal of the Society of Chemical Industry*, Oct. 15, 1918, p. 567a. (J. A. W.)

METALLURGY.

Aurocyanide Electrolysis.—"U. C. Tainton of Johannesburg, Transvaal, proposes to recover gold and silver from cyanide solutions with high base metal or low free cyanide content by the aid of an electrolytic cell, having as rotating cathodes a disc of wire mesh, or a thin sheet with serrated arms cut in it designed to pick up and hold metallic threads which may be introduced with the solution. The anodes are of lead, encased in a non-conducting rim and porous diaphragm, to prevent the anode products from mixing with the catholyte and causing resolution of the precipitated metal. The anode compartments may also be partly filled with alkaline sulphate solution to prevent disintegration of the metal, and are provided with vent pipes for the escape of gases generated. The rich solution enters the casing through a pipe, and part of the metal is precipitated in the meshes of the first rotating anode as it passes through. High current density and rapid rotation will cause the incoherent deposit to become detached and carried along with the electrolyte through successive openings in the anode compartments and whirling cathodes until the solution carrying substantially all the values as finely divided metallics is drawn off through a pipe and settled or filtered as desired."—U. C. Tainton.—*Chemical and Metallurgical Engineering*, April 15, 1918, p. 424. (J. A. W.)

New Chromium Deposits in Rhodesia.—"Over a year ago a deposit of high-grade chrome ore was discovered in the Umvukwes Range by Mr. A. Peake. A systematic survey has already proved the existence of 2,000,000 tons of ore, and further large quantities are expected. The ore occurs in a number of parallel lines extending over 30 miles and covering an area of 4,500 acres. An average test of 300 samples shows 53% chromic acid. Besides the massive ore there is an alluvial deposit covering 1,500 acres which yields a mineral that assays 48% chromic acid. Provided a branch line be constructed to connect the mines with the main line at Banket Junction (a distance of 30 miles), it is estimated that the cost of ore delivered at Beira will be less than 35s. per ton. There are plentiful supplies of water, fuel and labour. The property has been offered to the Imperial Government under special terms and the resident mining engineer of the British South Africa Co. has sent a very favourable report to the Government authorities."—*Journal of the Society of Chemical Industry*, Nov. 30, 1918, p. 435R. (J. A. W.)

Monel Metal.—"The constituent metals of Monel metal are present in the proportions occurring in the original ore mined at Sudbury, Canada. Analyses of the rolled bar give approximately 66% Ni, 30% Cu, 3·5% Mn + Fe, 0·13% Si, with small amounts of phosphorus and sulphur; and metal for casting contains 1 to 1½% Si. The structure of Monel metal is that of a solid solution, the rolled bar showing sharply defined crystal grains, usually twinned. Mechanical tests on the rolled rod show a tensile strength of 39·2 tons; elongation on 2 in., 38·5%; reduction in area, 66·9%; Brinell hardness number, 171. When annealed at 800° C. the tensile test does not fall below 34 tons per sq. in., with a Brinell number of 143, and the strength is not dependent on the work applied. Monel metal possesses considerable strength at high temperatures; at 500° C., a temperature at which naval and manganese brass have no mechanical strength, the tensile strength is nearly 29 tons per sq. in. Casting of the metal is rendered difficult by the high melting point (about 1360° C.) and the excessive shrinkage."—J. Arnott, *Engineering*, 1918, *106*, 451.—*Journal of the Society of Chemical Industry*, Nov. 30, 1918, p. 703A. (J. A. W.)

Refining Gold Bullion with Chlorine Gas and Air.—"At the Royal Mint, Perth, Western Australia, a modification of the Miller chlorine process and Rose's method for toughening gold bullion by means of oxygen, gas, or air, is used.

It is a common experience for the refiner using Miller's process to notice that, with various classes of bullion, which contain only gold and silver, the final stages of the refining process occupy only a short time; whereas, with bullion which contains, besides gold and silver, varying quantities of certain base metals, such as lead, antimony, etc., the final stages of the refining process take a considerable time. It is in the final stages of the chlorine process that the major portion of the losses of gold occur. In the literature of refining bullion by chlorine gas, only brief mention is made of the stage of the operation when the losses of gold occur. Most of the losses of gold take place in the final stages of the refining process.

Various methods were experimented with to attain this object, the most successful being as follows: Two clay pipe-stems are introduced into the refining crucible. One is connected to an air compressor delivering at a pressure of 6 or 7 lb. per sq. in., and the other to the chlorine generator. At the beginning of the refining operation the maximum amount of air is used, so much as will just avoid the globules of metal being projected through the borax cover, and a slow stream of chlorine. As the operation progresses the volume of air used is diminished, and that of the chlorine is increased, until finally, the air pipe is removed and chlorine alone is used. The principle governing the regulation of the air and the chlorine is that fumes should be prevented from leaving the borax cover; if the fumes become too voluminous more air must be used and less chlorine.

When using this method it is found an advantage to mix the brittle bullion with the bullion containing the most silver. If the refining does not appear to be progressing satisfactorily, it is beneficial to remove the borax cover, and replace it with fresh borax."—R. R. Kahan. *Mining and Scientific Press*, Jan. 11, 1918. (H. R. A.)

MINING.

Ore Minerals of Tavoy.—"*Conditions of Occurrence.*—The outstanding characteristic is that Tavoy ores are always found in the vicinity of the contact of the granite with the overlying sedimentary rocks. They may be found in either or in both, but never at any great distance above or below the contact. In many parts of the district I have observed, as original constituents of the granite, wolfram alone, cassiterite alone, and also both together in varying ratios, sometimes accompanied by bismuthite. Such occurrences are always near the surface of the granite, never deep down within its mass, and also never far removed from wolfram or tin-bearing veins.

Broadly speaking the most marked peculiarity of the veins is that they usually occur in groups parallel and close to one another, often very numerous, very narrow, and frequently of short length. We often find a second parallel series intersecting the first. Such deposits usually end abruptly along the strike, the ground outside not having been fissured or cracked.

Another characteristic of many Tavoy veins is that they diminish in both widths and values as they go downward.

Source and Method of Segregation.—It is only within the last few years that any interest has been displayed regarding wolfram, and even now no information regarding its origin is to be obtained from books. Certain theories were put forward by Elie de Beaumont and Daubrée about 70 years ago regarding the origin of cassiterite in veins. They were the result of laboratory experiments, the whole value of which depends upon whether water was or was not in gaseous condition at the points in veins where cassiterite was being deposited. Since cassiterite certainly travels in the fluid condition to veins, and since there was no known solvent to carry it in the liquid condition, the ingenious theory that it travelled as a gas (fluoride or chloride) was devised, and plausibility was lent by the fact that these vapours are decomposed by water, yielding the oxide. This was proved to be true in the laboratory. This theory has been accepted ever since and the name pneumatolysis was coined to indicate all such processes in nature. As long as chlorine, fluorine, and boron compounds accompanied cassiterite in the veins in adequate quantity the theory was quite credible, but what are we to do now that Tavoy veins show practically no chlorides, little fluoride, and never a crystal of tourmaline?

A theory based on laboratory experiments with tin gave birth to pneumatolysis, and promptly wolfram, scheelite, and other associates of tin were credited with a similar origin. Let us take the case of wolfram. I can see no evidence whatever of pneumatolytic origin but much evidence of aqueous origin. Wolfram was certainly in solution in the granite magma at its surface. We cannot ascribe its presence there, uniformly distributed, to pneumatolysis, nor is it credible that water in the magma was in the gaseous condition at the time the wolfram was imprisoned within it. The same argument applies to cassiterite when occurring as a primary constituent of granite.

Our past ignorance of a form in which tin could be transported in aqueous solution so as to deposit cassiterite in a vein is no proof that such does not exist.

Lindgren, writing in 1901 on 'Metasomatic Processes in Fissure Veins,' says that 'tin may be held in solution and deposited at ordinary pressures by thermal waters.' He quotes Prof. Winkler as showing that tin exists in granites and other acidic rocks in some cases not as cassiterite but chemically combined in silicates partly replacing silica; and he quotes also Verbeck, who refers to a hot spring in Malacca which deposits silicious sinter containing, according to an analysis by St. Meunier, 91·8% SiO_2, 0·5% SnO_2, 0·2% Fe_2O_3, and 7·5% H_2O. If hot silicious spring water at the surface deposits solids containing 0·5% cassiterite, how much more capable would similar silicous water be, at higher temperature and pressure, of transporting cassiterite from magma to veins.

The case of tungsten is even simpler than that of tin. Few know of the existence of a compound called silicotungstic acid; its formula is SiO_2, $4H_2O$, $12WO_3$. Silica is ordinarily insoluble in water, so also is tungstic oxide; yet five parts of silica when combined with six parts of water and 232 parts of tungstic oxide yield this substance, which is freely soluble in water and not decomposed by dry heat till over 350° C. The alkaline silicotungstates are also readily soluble in water.

I believe that highly silicious water under high pressure and at moderate temperatures is capable of carrying both tungsten and tin in solution, that this is the agent which extracts them from the granite magma and transports them to veins, and that they do not pass upward in gaseous form.

Wolfram and cassiterite are both found in veins at least 500 ft. above the surface of the granite, and if the result of pneumatolytic action, we are asked to believe that over 500 ft. in depth of sedimentary rock had been heated up to a temperature of about 350° C. There is no evidence of greater metamorphism of the sedimentary rocks in fissured than in unfissured areas.

The temperature at which even cassiterite was deposited in veins was probably much lower than is generally supposed.

In tin veins at Mount Bischoff, in Tasmania, chalybite (crystallized ferrous carbonate) is found. It occurs with tin and wolfram at Kanbauk, and probably elsewhere in Tavoy district, but is not easily identified. It is a mineral not the result of either pneumatolysis or deposition at a high temperature.

We have therefore good reasons for believing that highly silicious water was the agent which leached tin and tungsten from the magma and at quite moderate temperature deposited cassiterite, wolfram, and associated minerals in veins."—J. M. Campbell.—*Mining Magazine*, Feb., 1919, pp. 76-89. (C. J. G.)

MISCELLANEOUS.

Potash Availability in Common Soil Materials. —"The common soil-forming minerals, biotite, muscovite, orthoclase, and microcline, show little difference as regards the solubility of their contained potassium in water; but biotite and muscovite yield considerably more potassium to solutions of carbonic acid than do orthoclase and microcline. The solubility of the potassium in any of these minerals is not increased by lime in the form of calcium bicarbonate. Pot experiments have shown that oats, soya bean, rye, and cowpea take up different amounts of potassium from these minerals. For example, the increase in the yield of the dry matter of oats following the application of biotite is four times as great as with microcline and 66% as much as with potassium sulphate, whilst the increase with muscovite is nearly twice as much as with orthoclase. Analogous results are obtained with rye. The addition of calcium carbonate does not cause any material increase in the yield of dry substance or in the amount of potassium removed from the soil by oats or rye, but when used in conjunction with biotite it causes an increase in the yield of the dry matter of soya bean by about 33%. Calcium carbonate used in association with muscovite causes a pronounced increase in the growth of the plant, and a smaller increase when used in association with orthoclase or microcline. Soya beans and cow peas removed more potassium from soils treated with calcium carbonate in association with potassium sulphate, biotite, and muscovite, which may be attributed to the development of more favourable conditions in the soil for the growth of the plants, and not necessarily to more potassium having been dissolved. The addition of calcium carbonate does not appear to increase the solubility in N/5 nitric acid of potassium in soils treated with any of these minerals."—J. K. Plummer, *J. Agric. Res.*, 1918, *14*, 297-315.—*Journal of the Society of Chemical Industry*, Dec. 16, 1918, p. 744A. (A. W.)

Abstracts of Patent Applications.

175.18. J. R. Broadley. Improvements in or relating to machines for grinding ores, minerals, stones, and the like. 13.8.18.

This application refers to an attachment at the end of a tube or ball mill, consisting of screens to separate material already fine enough, and scoops or radial arms which would return the over size product into the mill.

725.18. W. E. Nettle (1), P. Selby (2), J. Blythe (3), J. H. Holman (4). Improvements in conveying liquid to rock drilling tools. 30.11.18.

This application is in respect of a watertight joint for use in a rock drill chuck using hollow steel.

A recess is formed in the chuck to receive a packing ring of rubber or other suitable material with a hole to fit the drill shank.

The chuck is further cut away to take a steel pad or block reaching down to the drill shank and secured by the usual U bolt, this pad is recessed on one side to take about half the width of the rubber ring, the depth of the recess radially being less than the thickness of the ring, which is thus subjected to compression against the shank when the pad is screwed home, making the required water-tight joint.

799.18. Thomas Binks Kitson. Improvements in or relating to furnaces. 27.12.18.

This application relates to improvements in furnaces of the producer gas fired type, and particularly such as is used for glass. The improvement consists in providing a pre-heating chamber or flue, immediately above the crown of the furnace and below the exhaust gas flue, of larger cross sections than the exhaust flue so that the incoming air will travel more slowly and absorb heat from the containing walls before being mixed with the producer gas in the combustion chamber. Means are also provided to direct the heat to any particular part of the furnace to prevent chilling around the working doors or delivery spouts.

5.19. Drakes, Ltd. (1), J. W. Drake (2). Retorts and apparatus in connection therewith for use in the manufacture of gas. 6.1.19.

This application related to the construction and arrangement of retorts such as used in the manufacture of coal gases. The object aimed at is the manufacture of varied gases at the same time, such as coal gas, water gas or producer gas combining two or three of these gases.

To attain this object, special secondary air connections are made and also passages from the producer into the retort which are under control either by damper or special valve.

34.19. Walter Hartz (1), S. H. Steels (2), W. Vorster (3). The battery finger safety bar. 18.1.19.

This application relates to improvements in battery finger locking devices, and consists in a hinged support which acts as a toggle to secure the finger in place while carrying the weight of the stamp.

65.19. H. Warburton (1), F. C. Fairholme (2). Shock absorbing cam mechanism for stamps for ore crushing and other purposes. 30.1.19.

This application refers to a scheme for placing a spring supported hinged portion in the battery cams to receive the first contact with the tappet and thus absorb or alleviate the shock of impact.

87.19. J. M. Draper. Improvements in separators for the treatment of coal, clays, ores, and the like. 8.2.19.

This specification describes a coal, clay, or ore washer for separating impurities, consisting of a separator in which as ascending current of water carries the lighter portions to an overflow situated towards the top of the apparatus while the heavier portions pass down and are discharged at the bottom.

143.19. Emile A. Barbet. An improved process for removing the tar from pyroligneous liquids. 1.3.19.

This application relates to the separation and recovery of tar from the liquid products obtained in carbonising processes, more especially in respect of wood.

A high cylinder is used which is partly filled with a dividing material, such as porcelain, quartz or coke, etc.

The liquid to be treated is allowed to enter the top of the cylinder, and a product such as cresol, which is a better solvent and has a greater affinity for tar than water, and has also a lower density than the liquid to be treated, is entered at the bottom.

The cresol carrying with it the tar is led off at the top, and the liquid residue is taken off at the bottom.

164.19. Emile A. Barbet. Improved process and apparatus for the treatment of pyroligneous liquids derived from the carbonisation. 10.3.19.

This application relates to the treatment of pyroligneous liquids.

The object aimed at is to effect a more complete elimination of the tar, and to obtain acetates of lime in a whiter and purer condition than is usually obtainable by other known methods.

A continuous process and apparatus, so combined as to allow of carrying out the process, are fully described in detail.

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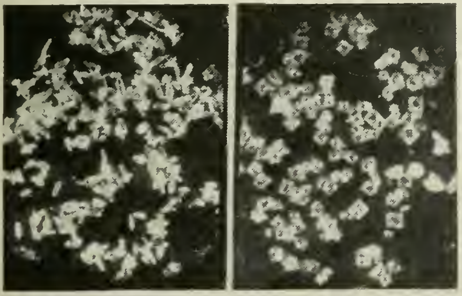
GOLD-ZINC-CYANIDE.

By W. R. Feldtmann (Past-President).

A double cyanide of gold and zinc which has, apparently, not hitherto been recorded, can be produced in two forms:—

(1) When solutions of, respectively, one equivalent of $ZnCl_2$ and two equivalents of $KAuCy_2$ are mixed and allowed to stand for some hours, crystals deposit which, although minute, are easily identified under a low power microscope as hexagonal prisms. These are nearly colourless, with just a perceptible greenish tinge. They form slowly in dilute solutions; *e.g.*, from a mixed solution carrying $\frac{1}{4}$% of $KAuCy_2$, crystals commenced to separate in half an hour, but continued to deposit for at least two days.



Zinc Gold Cyanide, Prismatic, Au_2ZnCy_4(?).

Zinc Gold Cyanide, Pyramidal, $ZnAu_2Cy_4$(?).

Similar crystals are obtained by adding HCl to a cold cyanide solution containing gold and zinc in the proportions above indicated, until the solution is just acid to methyl orange. Except for the resulting presence of free HCy, this amounts to the same thing as adding $ZnCl_2$ solution to $KAuCy_2$ solution. For $KAuCy_2$ is a neutral salt, and it has been found that K_2ZnCy_4, in dilute solution, requires four equivalents of HCl to neutralize it*, so that the point at which methyl orange shows commencing acidity is the point at which all free cyanide has been decomposed and the K_2ZnCy_4 has been converted to $ZnCl_2$ ($K_2ZnCy_4 + 4HCl = 2KCl + ZnCl_2 + 4HCy$).

(2) If a solution containing two equivalents $KAuCy_2$ is mixed with two equivalents KCy(†) and then with four equivalents of HCl, heated to boiling point and allowed to cool, and if a solution of one equivalent of $ZnCl_2$ is then added and the mixture allowed to stand for some hours, a slow separation of crystals again takes place. But the compound produced by this method is found to be composed of hexagonal pyramids or pyramidal combinations, in which the prism faces are absent. These crystals, also, are nearly colourless but, in bulk, have a perceptible grey or lavender tinge.

The same pyramidal crystals can be formed by adding to the acidified, heated and recooled gold solution a cyanide solution containing zinc in the proportion indicated, provided that sufficient HCl is present to render the final mixture just acid to methyl orange. If too little acid has been added, insoluble octahedra separate, similar to those referred to in footnote *, but carrying an appreciable amount of gold.‡

If, before the pyramidal crystals have time to form in the mixed solutions described above, the solutions are heated to boiling point, no pyramidal crystals appear, but only hexagonal prisms, *i.e.*, the prismatic is apparently the more stable form of the compound.

Gold and zinc were separated and estimated gravimetrically (the cyanogen being arrived at by difference) in both the prismatic and the pyramidal forms of the gold-zinc-cyanide. The percentage composition was found to be the same in both cases, viz.: 69% gold and 11·4% zinc, corresponding sufficiently closely to the empirical formula Au_2ZnCy_4, with 69·9% gold and 11·6% zinc. In their general chemical characteristics the two forms of the compound have not been found, so far as observed, to differ materially. Nevertheless there is a difference in origin, a difference in crystal habit and a consistent difference in such slight tinge of colour as the crystals show in bulk. Collectively these points seem to indicate that this is a case of isomerism, and not merely physical isomerism or allotropy, but chemical isomerism, possibly as between Au_2ZnCy_4 and $ZnAu_2Cy_4$, with gold as the base in the prismatic form and zinc as the base in the pyramidal form.

The formation of the prismatic isomer may be expressed as:—

$$ZnCl_2 + 2(AuCy, KCy) = 2KCl + (AuCy)_2ZnCy_2 \text{ (or } Au_2ZnCy_4\text{)}.$$

But the formation of the pyramidal isomer cannot be quite analogous, as $ZnCl_2$ is not acted on by HCy (on the contrary, $ZnCy_2$ is decomposed by HCl). The reaction of formation cannot therefore be:—

$$ZnCl_2 + 2(AuCy, HCy) = 2HCl + (AuCy)_2ZnCy_2.$$

but may probably be correctly represented as the action of aurocyanhydric acid on $ZnCl_2$, thus:—
thus:—

$$ZnCl_2 + 2HAuCy_2 = 2HCl + ZnAu_2Cy_4.$$

It should be noted that the reaction is an incomplete one, but the exact reason for this has not been ascertained.

In water, cold or hot, both forms of crystals are insoluble. They are slowly soluble in strong solutions of alkaline cyanides. Cold HCl, even if fairly concentrated, only attacks them slowly, with separation of AuCy. They dissolve readily in cold solutions of the alkalis and in ammonia. If, to the alkaline solution so formed, HCl is slowly added, zinc hydrate is precipitated which, on further addition of acid, redissolves. When sufficient HCl has been added to render the solution just acid to methyl orange, the zinc-gold compound separates again (slowly, if the solution was diluted considerably), but only in the prismatic form, whether the crystals dissolved were prisms or pyramids; *i.e.*, the reaction in this case is once more between $ZnCl_2$ and $KAuCy_2$. Sodium sulphide decomposes both crystals with separation of zinc sulphide and formation of alkaline aurocyanide. The zinc sulphide retains just a trace of gold which can easily be separated by treatment with dilute HCl and filtering, the zinc being reprecipitated in the filtrate. The sodium sulphide method of decomposition was found to be a convenient way of separating the metals for the purpose of analyzing the zinc-gold compound. When digested with a strong solution of potassium or sodium carbonate the crystals are decomposed with formation of zinc carbonate, the gold again going into solution as alkaline aurocyanide.

The crystals can be heated at considerably above the boiling point of water without undergoing any change. When the temperature is gradually increased they first lose cyanogen and become blackened with separated carbon. On further heating they become bright again, with a brassy gold colour, without loss of crystal form. When the temperature approaches red heat a sudden change becomes apparent, a red glow passes through the mass, the colour changes to a bronzy hue, and the crystals are then found to have fritted and lost their form.

Notes.—* For instance, one equivalent of neutral $ZnCl_2$ in solution diluted to 0·1%, mixed with six equivalents KCy—free from alkaline carbonate or caustic alkali—required *six* equivalents (not only four, as might be supposed) to turn methyl orange indicator permanently pink. Evidently, therefore, $ZnCy_2$ acts as an alkali to the indicator, in the same sense that KCy does. Trying successive additions of acid to stronger solutions, other conditions remaining the same, it was found that up to two equivalents of HCl produced no effect beyond decomposing the excess KCy. Further additions, up to four equivalents, caused a separation of a crystalline precipitate which formed slowly and is slightly soluble on heating the solution containing it. This precipitate, consisting of minute octahedra, has not been investigated. It may be a crystalline form of $ZnCy_2$, but appears just as likely to be H_2ZnCy_4 in which some, possibly irrational, proportion of hydrogen is replaced by potassium. On addition of the whole six equivalents of HCl, these crystals redissolve and the solution becomes clear.

† The HCy formed prevents premature precipitation of AuCy. It is interesting to note that, when an acidified solution of $KAuCy_2$ after being heated to near the boiling point, is somewhat suddenly chilled (if, say, the flask containing it is held under the cold water tap), AuCy immediately separates, even in the presence of excess HCy, whereas, if the solution cools slowly, it remains clear, the gold being held as aurocyanic acid.

‡ Some well washed crystals gave a zinc to gold ratio of 15·8 to 2·5.

TABLE OF SOLUBILITIES OF OXYGEN IN WATER*

(In milligrams per litre).

By H. A. White (*Member of Council*).

Mercury Absolute Pressures ... m.m.			0	13	38	63	89	114	165	216	267	318	368	495	622	650	700	750	760
Absolute Pressures ... inches			0	0·5	1·5	2·5	3·5	4·5	6·5	8·5	10·5	12·5	14·5	19·5	24·5	25·6	27·6	29·5	29·9
Vacuum Gauge, J'brg, inches			**24·5**	**24·0**	**23·0**	**22·0**	**21·0**	**20·0**	**18·0**	**16·0**	**14·0**	**12·0**	**10·0**	**5·0**	**0**				
Tension of Water Vapour, m.m.	Temperature, C°	F°																	
6·5	**5**	41		0·1	0·5	0·9	1·3	1·8	1·6	3·4	4·2	5·1	5·9	8·0	**10·16**	10·6	11·4	12·2	**12·41**
7·0	**6**	43		0·1	0·5	0·9	1·3	1·7	2·5	3·3	4·2	5·0	5·8	7·8	**9·93**	10·4	11·2	12·0	**12·14**
7·5	**7**	45		0·1	0·5	0·9	1·3	1·7	2·5	3·3	4·1	4·9	5·7	7·7	**9·72**	10·2	10·9	11·7	**11·88**
8·0	**8**	46		0·1	0·5	0·8	1·2	1·6	2·4	3·2	4·0	4·7	5·5	7·5	**9·51**	9·9	10·7	11·5	**11·62**
8·6	**9**	48		0·1	0·4	0·8	1·2	1·6	2·3	3·1	3·9	4·6	5·4	7·3	**9·30**	9·7	10·5	11·2	**11·37**
9·2	**10**	50		0·1	0·4	0·8	1·2	1·5	2·3	3·0	3·8	4·5	5·2	7·1	**9·09**	9·5	10·2	11·0	**11·11**
9·8	**11**	52			0·4	0·8	1·1	1·5	2·2	3·0	3·7	4·4	5·1	6·9	**8·89**	9·3	10·0	10·7	**10·86**
10·5	**12**	54			0·4	0·7	1·1	1·5	2·2	2·9	3·6	4·3	5·0	6·8	**8·71**	9·1	9·8	10·5	**10·64**
11·2	**13**	55			0·4	0·7	1·1	1·4	2·1	2·8	3·5	4·2	4·9	6·6	**8·52**	8·9	9·6	10·3	**10·41**
11·9	**14**	57			0·3	0·7	1·0	1·4	2·1	2·7	3·4	4·1	4·8	6·5	**8·33**	8·7	9·4	10·0	**10·18**
12·7	**15**	59			0·3	0·7	1·0	1·3	2·0	2·7	3·3	4·0	4·7	6·3	**8·14**	8·5	9·2	9·8	**9·95**
13·5	**16**	61			0·3	0·6	1·0	1·3	1·9	2·6	3·3	3·9	4·6	6·2	**7·98**	8·3	9·0	9·6	**9·75**
14·4	**17**	63			0·3	0·6	0·9	1·3	1·9	2·5	3·2	3·8	4·4	6·0	**7·82**	8·2	8·8	9·4	**9·55**
15·4	**18**	64			0·3	0·6	0·9	1·2	1·8	2·5	3·1	3·7	4·3	5·9	**7·65**	8·0	8·6	9·2	**9·35**
16·4	**19**	66			0·3	0·6	0·8	1·2	1·8	2·4	3·0	3·6	4·2	5·8	**7·49**	7·8	8·4	9·0	**9·15**
17·4	**20**	68			0·3	0·5	0·7	1·1	1·7	2·3	2·9	3·6	4·1	5·6	**7·35**	7·7	8·3	8·8	**8·98**
18·5	**21**	70			0·2	0·5	0·7	1·1	1·7	2·3	2·9	3·5	4·1	5·5	**7·21**	7·5	8·1	8·7	**8·81**
19·7	**22**	72			0·2	0·5	0·7	1·1	1·6	2·2	2·8	3·4	4·0	5·4	**7·07**	7·4	7·9	8·5	**8·63**
20·9	**23**	73			0·2	0·5	0·7	1·0	1·6	2·2	2·7	3·3	3·9	5·3	**6·95**	7·3	7·8	8·4	**8·49**
22·2	**24**	75			0·2	0·4	0·7	1·0	1·6	2·1	2·7	3·3	3·8	5·2	**6·83**	7·1	7·7	8·2	**8·35**
23·6	**25**	77			0·2	0·4	0·7	1·0	1·5	2·1	2·6	3·2	3·7	5·1	**6·74**	7·0	7·6	8·1	**8·23**
25·0	**26**	79			0·1	0·4	0·7	1·0	1·5	2·0	2·6	3·1	3·7	5·0	**6·65**	6·9	7·5	8·0	**8·12**
26·5	**27**	81			0·1	0·4	0·7	0·9	1·5	2·0	2·5	3·1	3·6	4·9	**6·55**	6·9	7·4	7·9	**8·01**
28·1	**28**	82			0·1	0·4	0·6	0·9	1·4	2·0	2·5	3·0	3·5	4·9	**6·48**	6·8	7·3	7·8	**7·92**
29·8	**29**	84			0·1	0·3	0·6	0·9	1·4	1·9	2·4	3·0	3·5	4·8	**6·41**	6·7	7·2	7·7	**7·83**
31·5	**30**	86			0·1	0·3	0·6	0·9	1·4	1·9	2·4	2·9	3·4	4·7	**6·35**	6·6	7·1	7·6	**7·76**

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*In contact with air at various temperatures and pressures. Based on Roscoe and Lunt's tables and Henry's law. Weight of 1 cc. oxygen at N.T.P. = 1·4296 mgm. (Rayleigh). Highest vacuum obtainable at Johannesburg taken as 24·5 in. of mercury. Tension of water vapour (Sutton) is deducted from absolute pressures below 622 mm. mercury.

Correspondence and Contributions (Continued.)

AVAILABLE LIME.

Having been away for some time I missed my chance of discussing Mr. Meiklejohn's paper on the above subject.

However, the particular thing I want to call attention to is the question of CO_2 in the distilled water used to dissolve the sugar and lime. Mr. F. W. Watson, on p. 250 of the May number, suggests that the effect of the CO_2 may be destroyed by neutralising the water with NaOH using phenolphthalein for the end-point, but I wish to point out to him (what he knows perfectly well already) that this end-point is at $NaHCO_3$, not Na_2CO_3, and that therefore when CaO is added to the $NaHCO_3$ the products are $CaCO_3$ and NaOH, only one molecule of the latter resulting, whereas the CaO corresponds to two. The lime-valuation will therefore be low. The correct procedure to destroy CO_2 in water for this purpose is to add *twice as much* NaOH as is required to give the phenolphthalein end-point, thus converting the CO_2 into Na_2CO_3, which when treated with lime does not destroy any of its soluble alkalinity. As Mr. Watson says, rosolic acid is worse than phenolphthalein for this purpose, and it is a pity there is no indicator which will tell sharply when Na_2CO_3 is completely formed and free NaOH commences to be present.

The only other improvement I would suggest is to cut down the amount of water used. I think that 250 cc. of 8% sugar solution will give truer results than 1,000 cc. of 2% sugar. According to the table in Seidell's *Solubilities*, there is no diminution of the solubility of lime in sugar as the latter is increased, the dissolved lime being 27·5% of the sugar present over a wide range. This means that a compound $(5CaO + 3C_{12}H_{22}O_{11})$ is formed, possessing a very high solubility. Consequently the presence of 8% of sugar in the solution will make the lime dissolve quite fast.

JAMES MOIR.

Notices and Abstracts of Articles and Papers.

CHEMISTRY.

DETERMINATION OF SMALL QUANTITIES OF NITRITES AND HYDROGEN PEROXIDE.—"The bromine water usually employed for the oxidation of the sulphur present in thiocyanates to sulphuric acid, to be estimated as barium sulphate, may be conveniently replaced by nitric acid and sodium nitrite: to 5 cc. of thiocyanate solution mixed with 50 cc. of water was added 2 cc. of concentrated nitric acid, the liquid being heated over a small flame, and a solution of 1 gm. of sodium nitrite in 20 cc. added, drop by drop and with stirring, before the temperature reached about 60° C.: the solution was then heated to boiling and barium chloride added immediately. Percentage of thiocyanate thus found in solution was 6·15, whilst with bromine the result was 6·18.

The following reagent gives a blood-red coloration with a nitrite, the reaction being capable of detecting about 1 part of nitrite per 200,000,000 of solution: to 100 cc. of the above potassium thiocyanate solution are added 0·5 gm. of crystallised ferrous sulphate and 2 cc. of pure, colourless nitric acid diluted with an equal volume of water, the liquid being then stirred until the ferrous sulphate is completely dissolved. Two cc. of the reagent is added to 25 cc. of the solution under examination. A similar reaction, though less intense, is given by hydrogen peroxide (1 : 30,000,000), potassium persulphate, and probably other compounds of the type of hydrogen peroxide, but not by chlorates or perchlorates. With hydrogen peroxide, the maximum coloration is reached almost instantaneously, but with nitrites, slowly and with characteristic striation. If the reaction is positive and the coloration does not change at all when the liquid is heated rapidly to boiling with hydrochloric acid and urea, hydrogen peroxide is present, but no nitrite, and the peroxide may easily be determined colorimetrically. If the reaction is positive and the liquid becomes paler but not colourless when boiled with hydrochloric acid and urea, both nitrous acid and hydrogen peroxide are present, the former in excess. If the reaction is positive and the coloration disappears or, rather, becomes similar to that obtained with distilled water, on boiling with hydrochloric acid and urea, only nitrous acid or excess of this and a small proportion of peroxide may be present."—A. QUARTAROLI. *Gaz. Chim. Ital.*, 1918, *48*, I., 102-111.—*Journal of the Society of Chemical Industry*, Dec. 16, 1918, p. 731A. (A. W.)

ILSEMANNITE.—"A considerable deposit of molybdenum ore has been found near Ouray, Utah. It is a sandstone containing ilsemannite, a blue compound, soluble in water, to which the formula $MoO_2.4MoO_3.6H_2O$ is given. Lead and vanadium are absent. Analysis of an air-dried sample gave: 65·92% SiO_2, 4·35% Fe_2O_3, 12·27% Al_2O_3, 0·35% TiO_2, 1·36% CaO, 0·50% MgO, 1·22% MoO_3, 11·09% of sulphur as SO_3, 1·01% moisture, loss on ignition 4·89%. The dark blue solid obtained from the water-soluble portion contained 23·85% of molybdenum as MoO_3 and 38·5% SO_3. The blue compound was extracted with ether in a hydrochloric acid solution and the molybdenum occurring as MoO_2 determined by titration with N/100 permanganate. The total molybdenum was obtained by fuming with sulphuric acid and passing the solution through a Jones' 'reductor' (see Mellor's 'Quantitative Inorganic Analysis,' 1913, p. 190). The molybdenum may be extracted from the ore with water, dilute acids, dilute alkali carbonates and alkalis, and by roasting with a small amount of the reagents followed by a water leach. The best results corresponding to an extraction of about 89% of the molybdenum, were obtained with a cold water leach followed by hot treatment with 15% sulphuric acid or by treatment of the ore with caustic soda."—H. F. YANCEY. *Chem. and Met. Eng.*, 1918, *19*, 186-190.—*Journal of the Society of Chemical Industry*, Oct. 15, 1918, p. 589A. (A. W.)

THE SYSTEM LIME-ALUMINA-SILICA IN ITS RELATION TO PORTLAND CEMENT, ETC.—"The author gives a brief review of the present state of knowledge in regard to the ternary system CaO-Al_2O_3-SiO_2, and its relation to blast-furnace slags and Portland cement, based principally on the results of recent investigations at the Carnegie Institution, Washington. Blast-furnace slags and Portland cements occupy only small regions in the triangular diagram representing the complete ternary system. Johnson's work on blast-furnace slags is referred to, and the differences obtaining in blast-furnaces using charcoal and coke respectively are pointed out. In furnaces heated by coke, the sulphur in the latter necessitates the use of more lime ($CaO : SiO_2 = 1{\cdot}5 : 1$) as flux, and a corresponding rise of about 200° C. in the flowing temperature of the slags. Calcareous slags are of low viscosity compared with the viscous, tough silicious slags. The temperature at which calcareous slags flow freely is only slightly above their softening point; silicious slags require a difference in temperature of 200°—300° C. If the silica content is increased to 37% ($CaO : SiO_2 = 1{\cdot}35 : 1$) the slag flows readily at a lower temperature, but the metal is not desulphurised; if the silica is reduced below 32%, both the furnace temperature and the amount of slag must be increased. Thus increasing the proportion of lime beyond a certain limit does not further improve the desulphurisation, the increased basicity being more than counterbalanced by the greater 'stiffness' of the slag. Portland cements of good quality are comprised within the lines in the triangular diagram representing $3CaO,SiO_2$, $3CaO,Al_2O_3$, and $2CaO, SiO_2$. Portland cement made from pure materials and burned at a sufficiently high temperature would consist solely of these three substances. In commercial cements, the natural impurities in the materials result in free lime or free $5CaO,3Al_2O_3$ being present, together with small quantities of magnesia, iron oxide, etc. As no ternary compound is present in the area of the triangular diagram occupied by cements, the theory of Jänecke and others that Portland cements consist chiefly of alite ($8CaO, Al_2O_3, 2SiO_2$) and other ternary compounds is untenable. Rankin's work on Portland cement is reviewed and the following summary of the compounds formed in the production of Portland cement is given:—

Cement.	Composition of raw materials.	%	Burning temp.	Constituents in finished cement.
Chemically pure cement	CaO Al_2O_3 SiO_2	68·4 8·0 23·6	1650°C	$2CaO, SiO_2$ $3CaO, SiO_2$ $3CaO, Al_2O_3$
White cement	CaO Al_2O_3 SiO_2 $MgO, Fe_2O_3, Na_2O, K_2O$	66·2 6·4 25·0 2·4	1525°C	$2CaO, SiO_2$ $3CaO, SiO_2$ $3CaO, Al_2O_3$ Trace CaO
Commercial (grey) cement	CaO Al_2O_3 SiO_2 $MgO, Fe_2O_3, Na_2O, K_2O, SiO_2$	63·2 7·7 22·4 6·7	1425°C	$2CaO, SiO_2$ $3CaO, SiO_2$ $3CaO, Al_2O_3$ Trace CaO, $CaO, 3Al_2O_3$ and ferrite

If the clinker is insufficiently burned, there will be a deficiency of $3CaO.SiO_2$. The tricalcium silicate appears to be the most valuable constituent of the cement; the dicalcium silicate hardens too slowly and the aluminate too rapidly. As the temperature of formation of tricalcium silicate is about 1700° C., it is desirable to find some flux by means of which it can be produced at a lower temperature; ordinarily, calcium aluminate appears to have this effect. Rankin has suggested that the substitution of iron oxide for part of the alumina may lead to important industrial developments, and the author suggests that an investigation of the properties of the iron Portland cements is also desirable."—B. NEUMANN, *Stahl u. Eisen*, 1918, *38*, 953-960.—*Journal of the Society of Chemical Industry*, Dec. 31, 1918, p. 770A. (A. W.)

METOL, SULPHATE OF *N*-METHYL-P-AMIDOPHENOL. —"Crystallizes from water in colourless needles which under the microscope appear as six-sided prisms having roof-like ends. When a solution of mercuric acetate is added to a solution of the salt the resulting solution assumes an intense purple coloration. This colour comes gradually, about three minutes elapsing before the full colour is developed. In solutions of 'Metol' stronger than 1—1000 the production of the colour is accompanied by the precipitation of beautiful scales which were found to be mercurous acetate, and the colour in this concentration is best described as being very similar to that of ordinary grape juice. The formation of mercurous acetate would indicate that the colour is an oxidation product. The colour observed by Clark upon treating 'Metol' with a solution of ferric chloride, is no doubt also produced by oxidation of the amine, but the colour caused by mercuric acetate is many times more intense.

Hydroquinone and the salts of *p*-amidophenol give no colour at all when treated with mercuric acetate, and since the colour is developed by a very small quantity of 'Metol' (a solution 1—100,000 giving a very good intensity) this reaction might be used to estimate the compound colorimetrically, and some experiments with the Schreiner colorimeter gave promising results."—R. N. HARGER.—*Journal of the American Chemical Society*, Feb., 1919, p. 276. (H. A. W.)

[Editorial Note.—This reaction cannot be used to detect mercury in cyanide solutions.]

FUEL ECONOMY.—"The *Electrical Review* of Chicago states that coal conservation to an astonishing degree is the result of the discontinuance of 24 privately operated plants in Chicago, and the consequent operation of their systems by central station service. The estimated saving in coal occasioned by this change reaches the excellent total of 54,840 tons a year. By these plants taking over central station service a total daily requirement of 2,172,000 kw.-hours has been added to the Commonwealth Edison Co.'s operating system—a figure that approximates an addition of nearly 17,000 h.p. In addition to the above, the power division of the Commonwealth Edison Co. has closed, since 1st January some 48 contracts calling for large installations on the company's lines. The estimated annual coal saving made by these plants using central station service is, approximately, 100,515 tons. It also means a service addition of 8,190,000 kw. hours, or 17,663 h.p."—*Indian Engineering*, Dec. 7, 1918, p. 317. (J. A. W.)

Deoxidizing Water to Prevent Pipe Corrosion. "No new work was undertaken in the past year on the application of the deoxidation principle for the prevention of corrosion in pipe. However, the new test pipes put into the Irene Kaufmann Settlement installation two years ago, where deoxidized water is used, have been re-examined. The following abstract from a report of the Pittsburgh Testing Laboratory summarizes the results to date:—

The pipes included in this test were originally two 29-in. lengths, each of 2 in uncoated black steel pipe, and 2 in. wrought iron uncoated black pipe.

The installation was made November 22, 1916, on which date it was first put into service. On December 24, 1917, the pipe line was reopened, and the wrought iron pipe and steel pipe were found to be practically uncorroded after more than one year of service. Their inner surfaces were covered with a soft, black slime. Oxygen removal by the deoxidizer had at times been incomplete, because of the low temperature of the water. Nevertheless, corrosion had resulted, during this time, in perforation of duplicate pipes in part of the same hot-water system unprotected by the deoxidizer.

Samples of the zinc and brass which had been in the line for 42 days showed practically no corrosion, whereas similar samples in the unprotected part of the hot water line showed pitting of the zinc and solution of the zinc constituent of the brass, leaving metallic copper at the edges of the brass samples. The zinc and brass specimens were put back into the line, and riveted couples of steel and copper sheets, and of steel and brass sheets, were also placed in the line. Copper rivets were used.

On January 3, 1919, after two years and 42 days of service, the condition of the pipes in the deactivated hot water line was again observed, and found to be so good that it was decided to continue the test for at least another year. The pipes showed the same soft black coating, and there was no evidence of pitting, even where the steel pipe was in contact with a brass union, a condition favourable to rapid corrosion by electrolytic action.

The specimens already mentioned were removed, and sent to the laboratory to determine their losses in weight and general condition. The relative losses of weight were striking. The zinc plate had lost in the deactivated water, in about 12 months, only 1%, as compared with 10% in the untreated water in the same line. The brass plates, during the same period, lost less than 0·1%, in the deactivated water, as compared with more than 1% in the untreated portion of the water in the line. The steel in the riveted brass and steel couple lost about 16% in the deactivated water, but was entirely corroded away in the untreated water in the same line. In the case of the riveted steel and copper plates, the loss of weight of the steel in the deactivated water was 20%, whereas in the untreated water the steel was destroyed by corrosion before the end of the 12 months' period.

Removal of the oxygen by the Speller deoxidizer has been the means of hindering the corrosion of wrought iron and steel pipe exposed for over two years in a hot water line. In the meantime, specimens of the same iron and steel pipe have failed by pitting in less than a year in an unprotected part of the same hot water line.

The plant at the Irene Kaufmann Settlement, Pittsburgh, has now been in use continuously for over three years. An analysis of the water shows the same percentage of oxygen removal as was found when the plant was installed.

Interesting data were obtained at the inspection this month, from test plates of zinc and some pieces of steel riveted to copper and brass plates. These were all weighed and inserted into hot-water lines carrying about the same volume of raw and deactivated water for about 14 months, and a greatly reduced loss of weight for the zinc and brass plates in deoxidized water was noticeable. The free oxygen in this water was reduced on the average to about 7% of the amount found in the raw water, so that, with a larger plant and more perfect deoxidation, still better results might be expected.

There has been considerable trouble with some brass pipe with ordinary hot water, owing to development of porosity and leaks, which are first manifested by a white incrustation on the outside of the pipe. In galvanized pipe, the zinc dissolves rapidly, and in this way protects the iron, but the protection is good for only two or three years under conditions in which the waters are moderately soft. So it appears that the brass pipe will be protected in practice by the removal of free oxygen almost as much as galvanized pipe.

It is of practical interest to note that, in the three years' trial which this system has undergone, the oxygen removal has not been complete, yet there is no perceptible action of the deactivated water on unprotected iron, steel, or brass pipe. A considerable amount of hydrogen has been found in this water, between which and the free oxygen some proportionate ratio would seem to exist, which inhibits corrosion."—F. N. Speller.—*Engineering and Mining Journal*, March 15, 1919, p. 480. (H. A. W.)

METALLURGY.

Coal Dust Firing of Blast Furnaces.—"The increase in the price of coke in the last few years, and the ever-pressing demand for lower smelting costs, have led the metallurgist to try pulverized coal in the blast furnace. The experiments have been so successful that there is every reason to believe that the blast furnace will regain its former place in the smelting industry and again prove a serious rival to the reverberatory.

When coke is introduced into the blast furnace with the ore and flux, it is partially consumed by the surplus oxygen of the blast before it reaches the point where it is most needed. Even in rare instances, when the oxygen delivered at the tuyeres is practically all combined with the sulphur, iron and carbon in the lower part of the furnace, the hot, ascending sulphur dioxide gases, coming in contact with hot coke above, are decomposed and the coke consumed.

The logical place, therefore, for the introduction of fuel is at the bottom of the charge, a little above the level of the molten slag in the crucible. This condition is secured in coal dust firing.

By the introduction of coal with the blast, the abundance of oxygen in intimate contact with the finely divided coal, ensures its complete combustion at a point a little above the level of the tuyeres, and, consequently the utilization of all the heat generated. It has been found in practice that the coal necessary to keep the furnace in good running condition is only 55% of the coke used on the same charge. The furnace runs more smoothly and gives less trouble with crusts when using the coal. No coke whatever is used except for 'blowing-in.'

In the blast furnace, the fuel maintains the temperature at which the various reactions take place, and supplies the reducing agent in roasted ore smelting. The substitution of coal dust for coke does not seem to make any material change in the condition of the lower part of the charge, nor alter the character of the slag or matte. In the absence of coke, however, the sulphur of the incompletely-roasted ore takes the place of carbon in the reduction of Fe_2O_3 to FeO and makes for greater concentration.

It has not yet been demonstrated that coke may be entirely dispensed with in lead smelting, or that carbon monoxide, from coal dust in excess of what the blast is capable of burning to carbon dioxide, will prove as satisfactory a reducing agent for lead oxide as coke.

All coals are not suitable for the manufacture of coke; but almost any coal may be used in the blast furnace. It is possible that peat or any other carbonaceous material, capable of being pulverized, may be successfully employed."—T. W. Cavers.—*The Canadian Mining Journal*, Feb. 12, 1919, p. 82. (C. J. G.)

MINING.

Sampling. — "The author discusses sampling generally on the basis of experiences with the buying of large consignments of magnesite.

The following are the more important points and conclusions in the paper.

The care and expense involved in analytical work is in many cases out of all proportion to the accuracy of the sampling.

The ordinary precautions of care in quartering down and keeping clean of machines cannot be too strongly emphasised.

With certain materials there is a tendency to segregation where samples are sent by post or are allowed to lie about; for example, the graphite in pig iron, crystals of quartz, spinel or magnetite in a softer matrix, such as magnesite.

In the case of the consignments of magnesite it was found that there were serious disagreements between the ordinary 'grab' samples taken from trucks. Thus the buyer's sampler, known to be reliable, was unconsciously influenced by his knowledge that silica over a certain percentage was detrimental, and was inclined to pay undue attention to siliceous material. A method tried to eliminate the personal factor was to throw a net over the surface of each truck, and to take a chip of approximately uniform size wherever a knot fell. This gave better results, but objections to the method were the small bulk of the samples, equal only to 0·05% of the total, and the fact that no fine material which in truck hauling tends to sink to the bottom, was included.

The final method adopted was to greatly increase the bulk of the original sample up to 2 or 3% of the whole. This large sample was immediately put through a small mill and the crushed magnesite sampled by taking shovelfuls periodically as it left the mill.

A point of interest was that the stope analyses at the mine showed generally less silica than the buyer's samples. The explanation given was that the stope samples did not include the inevitable waste rock mined by miners paid on a tonnage basis, and also that when chutes are inclined there is a tendency for wall material to be brought down with the falling ore. In one chute it was found that fine material tends to gather at certain points till it reaches a certain volume when a small avalanche descends, giving an undue proportion of fine to a particular truck.

The author concludes with an example of great differences in the analyses of four samples of manganese ore due to the different methods of sampling, and points out that it is useless to base elaborate metallurgical calculations on such results."—F. W. Bunyan, *Mining and Scientific Press*, Dec. 21, 1918, p. 827, (H. R. A.)

MISCELLANEOUS.

Erinoid.—"On the occasion of the opening of a new power installation at the company's works at Stroud, Gloucestershire, at the end of June, Mr. A. Binnie (chairman) claimed that Erinoid, Ltd., had vastly improved upon the German process of manufacture. Before the war Germany had an absolute world monopoly of this product (known there as 'Galalith'), which is made by treating (imported) casein derived from skimmed milk with formaldehyde, and is used for a large variety of purposes—*e.g.*, as an insulator, and as a non-inflammable substitute for ivory, amber, tortoiseshell, coral, bone, ebony, etc. It is employed in electrical work, for aeroplanes, in the manufacture of buttons, pianoforte keys, and as a substitute for certain kinds of celluloid. Large quantities of 'Erinoid' are now being made for export to France, America, Italy and Spain, for warlike and other purposes." — *Journal of the Soceity of Chemical Industry*, Aug. 15, 1918, p. 309R. (A. W.)

Utilization of Fish Waste.—"The commercial feasibility of using for fertilizers, or as food for live stock, the immense quantities of fish waste now unused in Canada, is suggested in a report issued by the Commission of Conservation. It is estimated that the fish waste in Canada is about 46% of the catch. In the lobster packing industry, the waste is about 75%. On the great lakes 44% of the total annual catch is waste. An experimental plant, established at Port Dover on Lake Erie in 1916, demonstrated the practicability of converting such waste into marketable products. Further experiments as to the food values of the fish meal manufactured at this plant are now being carried out at the central experimental farm at Ottawa."—*Journal of the Society of Chemical Industry*, Oct. 15, 1918, p. 378R. (A. W.)

The Rivetless Ship a Possibility.—"Electric welding as a substitute for riveting is being tested by the U.S.A. Government at four shipbuilding yards, and so far the work is proving highly satisfactory. According to recent data, the process will increase the strength of the joint at least 25% and decrease the time of building a hull nearly 50%. Eminent marine engineers claim that there will be a saving in labour of 60% to 70%. The machine employed is the Wilson welder. At present the plates are being lap-welded, the plates being overlapped at least 2 in. (5 cm.), sometimes more, and each edge welded down. In the future it is the intention to butt-weld the plates, in which case they will be bevelled so that when placed edge to edge V-shaped grooves will be formed, into which the welding metal will flow, leaving a welt over the top of the V. The reverse side, the one exposed to the sea, will be left perfectly smooth.

By this method considerable steel will be saved which otherwise is wasted by over-lapping, and, at the same time, the weight of the ship will be reduced. Plates 3½ in. (9 cm.) in thickness have been welded, this being the maximum thickness used on the particular jobs where observations are being made. The advisability of casting entire steel sections and then welding them together is also under consideration. Repair work can be done without removing the broken parts from a ship. No preheating or annealing is necessary. A novice can be developed into a satisfactory electric welding operator in 30 days, and from available data it is estimated that 30 welders can do the work of 125 riveters. The Wilson welding outfit operates on what is known as the arc principle, and consists of a motor generator set, the generator of which is wound for 35 volts. The welding metal serves as one electrode, while the ship plates constitute the other electrode."—*Indian Engineering*, Aug. 21, 1918, p. 107. (J. A. W.)

Abstracts of Patent Applications.

117.18. W. S. Mackintosh. Improvements in furnaces or forges for heating rock drills and for other similar purposes. 23.2.18.

This application relates to improvements in furnaces or forges for heating rock-drills and for other similar purposes, and has particular reference to the type of furnace in which liquid fuel is used. The improvements claimed are :

(1) The design of burner, which is in the form of a choke tube with a central jet of compressed air which sprays the liquid fuel, and has a regulator for the induced air, and

(2) Details of arrangements for pre-heating the compressed air, the induced air and the liquid fuel.

321.18. R. Jones. Improvements in rollers, idlers, and similar devices for supporting travelling ropes, conveyor belts and the like. 17.6.18.

The roller consists of a drum or barrel portion, two end plates, and a tubular bearing member positioned between the end plates and connected thereto. The position of the bushes which are non-rotatable are mounted upon the stationary spindle of the roller.

The application also provides for soft packing rings in the annular recess near the inner end of the bushes to prevent the passage of excess lubricant between the bearing tube and the bushes.

171.18. International De Lavaud Manufacturing Corp., Ltd. Improvements in process and apparatus for the manufacture of metal articles by rotary or centrifugal means. 12.8.18.

This application relates to an improved method of, and apparatus for, producing metal castings of circular form by the use of rotary moulds.

763.18. Amalgamated Zinc (Debavay's), Ltd. Improvement in the recovery of lead and silver from sulphide ores and metallurgical products. 13.12.18.

This application relates to the recovery of lead and silver from sulphide ores, and metallurgical products.

91.19. W. L. H. Roberts. Improvements in furnaces. 8.2.19.

This application refers to tubular furnaces for calcining, drying, kilns, etc., and may be of any cross-sectional form suitable to oscillatory movements, the novelty claimed being the oscillatory movement in an inclined tubular furnace. Various means of producing the movement are claimed.

158.19. R. Pearson (1), H. C. Parkes (2). Fixation of nitrogen of the atmosphere. 6.3.19.

This application deals with fixation of atmospheric nitrogen, and claims an improvement by combining a heated catalyst and an electric spark discharge on mixtures of nitrogen and oxygen.

193.19. R. W. Easton. Improvements in or connected with the construction of retorts, coke-ovens and the like. 19.3.19.

The application relates to retorts for the continuous carbonization of coal, etc., and consists of two or more inter-meshing propelling screws which are arranged to work in a suitable casing which may be mounted either inside or outside the retort; the screws being driven by gearing mounted at either end or at both ends.

If the screw is mounted outside the retort, a further casing or an extension of the casing is mounted in the retort having suitable charging or discharging hoppers and gas outlet.

201.19. R. P. Park. Improved machine for separating minerals from ore bearing materials. 21.3.19.

This application is for a jig of the pulsating type in which the pulsations are developed by a piston acting through an air-chamber immersed in the liquid of the jig. The jig is of conical shape containing the usual supporting screens. Means are provided for regulating the pulsations both by varying the length of the stroke of the piston and by a manually operated air-vent connecting with the air-chamber.

210.10. C. H. Smith. Gasification of coal and obtaining of products. 22.3.19.

This application relates to the preliminary heating of high-volatile bituminous coals, previously crushed to a finely divided condition, to remove the tar vapours from the coal before being used in gas producers or water-gas producers, the subsequent recovery of those tar vapours, the conversion of the carbonaceous portion of the coal into gas or water gas in a producer, and the subsequent recovery of ammonia as a by-product from the producer gas.

218.19. E. A. Barbet. Process for removing tar from the products of the distillation of wood or coal. 27.3.19.

This application relates to a process for removing tar from the gases given off in the destructive distillation of wood or coal.

The process consists in the first place of using the known method of bubbling the gases through the tar itself, and secondly of further passing the gas through a suitable tar solvent, such as cresol or anthracenic oils.

Changes of Address.

Beaumont, R., *l/o* Florida; Crown Mines, Ltd., P.O. Box 102, Crown Mines.

Martin, H. Rose, *l/o* Johannesburg; P.O. Box 337, Benoni.

Strange, E. H., *l/o* Idaho; P.O. Box 588, Stockton, California, U.S.A.

Wraith, C. O., *l/o* Leeuwpoort (from Active Service); Mission de Delimitation, V.M.H.K., Elizabethville, Congo Belge.

THE JOURNAL
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Proceedings
AT
Ordinary General Meeting, September 20, 1919.

The Ordinary General Meeting of the Society was held in the South African School of Mines and Technology Building, Johannesburg, on Saturday, 20th September, 1919, Mr. Jas. Gray (President), in the chair. There were also present:—

22 Members.—Messrs J. Chilton, H. R. Adam, C. J. Gray, J. Hayward Johnson, A. King, J. J. R. Smythe, F. Wartenweiler, H. A. White, J. R. Thurlow, Dr. J. Moir, W. R. Dowling, Prof. G. H. Stanley (Members of Council), M. Baumann, T. Blandford, C. A. Meiklejohn, E. A. Osterloh, H. A. Read, J. Thorlund, T. P. Waites, H. R. S. Wilkes and J. S. Willcox.

10 Associates.—Messrs. R. C. Anderson, E. G. Bilse, J. A. Boyd, O. A. Gerber, J. Gibson, W. Russell, H. Rusden, H. Ward, A. A. Wood, J. A. Woodburn.

6 Visitors, and Fred. Rowland (Secretary).

MINUTES.

The Minutes of the Annual General Meeting, held on the 28th June, 1919, as recorded in the June *Journal*, were confirmed.

GENERAL BUSINESS.

DEATH OF GENERAL THE RIGHT HON. LOUIS BOTHA, P.C., M.L.A.

The President: At a time when South Africa was trying to forget personal losses in a moment of rejoicing over peace, she experienced the irreparable loss of her greatest son, Louis Botha. His high personal character is well known to you all. Pope has summed up all we could say of him in the following words:—

> "Statesman, yet friend to truth! of soul sincere,
> In action faithful, and in honour clear;
> Who broke no promise, served no private end,
> Who gained no title, and who lost no friend,
> Ennobled by himself, by all approved."

To Mrs. Botha and family our sincerest sympathy goes out in their sudden bereavement, and I would ask you to pass the following resolution by standing in silence:

> "We, the members of the Chemical, Metallurgical, and Mining Society of South Africa in ordinary meeting assembled, desire to express our sincerest sympathy with Mrs. Botha and family in their sad bereavement."

Carried unanimously, all members rising to their feet.

The President: I would suggest that we send a similar resolution to General Smuts and the Ministers of the Cabinet. Agreed.

NEW MEMBERS.

Messrs. J. R. Thurlow and W. R. Dowling having been elected as scrutineers in connection with the election of new members, the following were declared unanimously elected:

THOMSON, ALEXANDER ALEXANDER, B.Sc., A.R.S.M., c/o Messrs. R. Williams & Co., Elizabethville, Katanga, Congo Belge. Mining Engineer.

TRAVERS, JOHN WOLSELEY, Knight Central, Ltd., P.O. Box 91, Germiston. Mill Manager.

TREDGOLD, RALPH HENRY, Witwatersrand G.M. Co., Ltd., P.O. Box 1, Knights. Mine Surveyor.

WARD, HENRY ST. JOHN, A.M.I.Mech.E., Brebner School, Bloemfontein, O.F.S. Engineering Lecturer.

The following two gentlemen have been admitted to membership, as stated, by the Council:—

Associate.—

WOOD, ADOLF AGARS, Randfontein Central G.M. Co., Ltd., P.O. Box 1, Millsite. Assayer.

Student.—

HARDING, ELLIS GEORGE. Research Student (McGill University), c/o P.O. Box 52, Boksburg.

The Secretary: The Council have altered the standard of entrance so as to enable a number of the mine workers, whose salaries do not exceed £20 per month, to join the Society as Student Members, and the Council would be very glad if those who have learners under their control would notify them of the change, and endeavour to induce them to become student members, the subscription for which is 10/6 per annum. The application form must, however, be certified by the head of their respective departments.

ANNUAL MINING EXHIBITION.

The President: You will observe in the Agenda of this meeting that we propose holding the Fourth Annual Mining Exhibition from November 5th to 12th, 1919.* The scope of the Exhibition is outlined in the Agenda, and I am sure that you will all support us in making this exhibition a great success. As you are aware, owing to the war no exhibition has been held for the past five years, and we hope to reach the standard set up in the past. The Exhibition will probably be held in the Assembly Hall of this building. Further particulars can be obtained from the Secretary.

OBITUARY.

The President: I regret to state that since the last meeting, we have been notified of the deaths on active service of two Associates, Messrs B. A. Johnson and W. H. Poynton. The following members have also died: Messrs. A. L. Edwards, M. T. Murray, and Dr. J. Schlesinger-Delmore. Mr. Edwards was chiefly concerned with work in the country districts. With regard to Mr. Murray, he was the Lecturer in Metallurgy at the School of Mines here, and for a short while was a member of our Council. He died at the early age of 33. Doctor J. Schlesinger-Delmore, who died this week, was a foundation member of the Society, having been elected in June, 1894. He was undoubtedly the pioneer of chemical industries in the Union of South Africa, and the industries which he has built up at Delmore, Jacobs, and elsewhere will always be a memorial to him.

I would ask you to rise as a mark of respect to the memory of these gentlemen.

CLOSER WORKING AND JOINT HOUSING.

Mr. Percy Cazalet *(Member)*: My attention has been called to the fact that in Appendix 4 of my recent paper on "The Closer Working and Joint Housing of Technical and Scientific Societies on the Rand," omission occurs of any reference to the name of Sir Robert Hadfield, who was responsible for the translation and extraction of the notes included in Appendix 4, of which fact I was unaware at the time that I made use of these extracts from the Bulletin of the American Institute of Mining Engineers, August, 1918.

It is of course generally known that Sir Robert Hadfield has made himself responsible for a large amount of these extremely important and valuable translations and extracts from foreign technical literature, and all scientific and technical men who gain advantage from this important work of his should of course recognise to whom they are indebted for the very material assistance which his translations give them.

I hope Sir Robert will excuse my unintentional omission of reference to his work, and shall hope that any future issues of my notes on Closer Working will carry the necessary reference to the proper source of information.

PROPOSED WAR MEMORIAL.

The President: At the next meeting the question of a war memorial to those of our members who have fallen will be considered. I have been asked by the Council to mention the matter this evening in order that you might be aware it will be discussed.

DISPERSAL OF MERCURIAL FUMES FROM RETORTS.

Mr. J. F. Pyles *(Member)*: Mr. L. G. Stuart, the smelter at the Rose Deep, drives out mercurial and other fumes from retorts before opening them, by means of compressed air. To prepare a retort for this, a $\frac{3}{8}$ in. hole is bored in the retort door: into this is inserted a nipple with valve or cock attached. On the opposite side of the valve is a nipple and male part of a union coupling. When retorting is finished, a rock drill hose connected with the air main and carrying the corresponding part of the coupling, is attached to the door and air turned on for about five minutes. This not only dispels all fumes but cools the sponge as well. I might state here that the mercury from the retort is collected outside the furnace building; the fumes driven off by the blast are therefore discharged into the open.

The only objection to the use of compressed air for this purpose is the possibility that it may carry sufficient oil to cause an explosion when coming into contact with the hot air in the retort. I believe this danger is very remote, but to make sure that workmen take no risk, we make it a practice to first open the valve on the retort door and then to stand clear when air is turned on at the main.

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*The date has since been altered to 21st to 31st January, 1920.

So far as I know this device is not being used on the Reef, and I feel sure it will receive a hearty welcome from all who have to handle gold from a retort.

The President: I am sure we are very much indebted to Mr. Pyles for his contribution on this important subject. I would ask if there is any further discussion on the point?

Mr. H. A. White *(Member of Council):* We ought to at once admit that it seems to be a very excellent and novel suggestion, and I think we shall show our appreciation of it in the most suitable way by putting it into practice as early as possible.

VARIATION IN AMALGAMATION FROM NEW COPPER PLATES.

Mr. E. G. Bilse *(Associate):* During a period of close observation, I have noticed that the setting of, and amount of amalgam recovered from, newly installed copper plates vary considerably per plate, although, value of ore, running time, dressing, etc., are identical. Is this due to difference in purity of copper? If so, might I suggest that an analysis of the copper used, should be made before installation so that uniformity be guaranteed.

Mr. H. R. S. Wilkes *(Member):* With regard to this, I remember in the early days we used to find it very necessary to have our copper plates annealed, so that they were soft. Those that were hard amalgamated very badly; those that were soft took the setting at once and gave no trouble in dressing. Plates were also found unequally tempered, being hard in patches, giving rise to unequal setting. This question of annealing I suggest may be of greater importance than the quality of the copper.

COPPER FROM KATANGA.

Mr. H. A. White *(Member of Council):* I would like to say we have here on the table a specimen of the stalactitic malachite and a piece of native smelted copper from Katanga. A gentleman who has just come down from there gave it to me to show to you this evening.

The President: I would ask Mr. Chilton to take the chair, while I deliver my address.

Mr. Chilton (Vice-President), accordingly took the chair.

THE POSITION OF THE CHEMIST IN SOUTH AFRICA.

PRESIDENTIAL ADDRESS.

By Jas. Gray, F.I.C.

It is my privilege as President, at this the first meeting of the Society for the session, to deliver what is termed an inaugural address. This privilege is also usually said to be a pleasure, but if the truth be told I am sure that, speaking for those who have been in a similar position, we should say it is really a most trying ordeal.

I will commence by admitting frankly that I have studied the addresses which have been delivered by previous occupants of the Presidential Chair with a view to obtaining ideas as to a suitable subject for my address. (I think this is quite customary though not often confessed.) As a result of my investigations, I found that in some cases recent advances in the branch of science which the President professed had been enlarged on: in others a general survey of the subjects included in the Society's title had been made; and in a few instances the work of the previous year was discussed, with suggestions for the future.

As I consider that fewer pitfalls await those who speak on the subject with which they are familiar, I have decided to discuss, as briefly as possible, the position of the chemist in South Africa. I think I may claim to have a knowledge of this subject due to my intimate association during the past seven years with your sister Society—the South African Association of Analytical Chemists.

The importance of chemistry in relation to everyday economics was brought into prominence by the war; and in the new era which is forecasted, we expect it to be generally realised that the encouragement of chemistry is essential for the well-being of the State.

Shortly after the outbreak of the war, I read in an American chemical journal, an article dealing with the recent recognition of the chemical profession by the public, especially in its relation to the coal-tar industry. In it occurred the following paragraph which to my mind was particularly apt:—"The public acknowledgment of our "responsible connection with this important "ant industry is a great accomplishment "for our profession when we recall that "only six months ago, the chemist was "known chiefly by the drug store he kept."

Undoubtedly, an erroneous impression exists in the mind of the public on the relation between the "chemist" and the "pharmacist," and it is desirable that steps should be taken to alter this.

The ignorance of the public and also of the Government in connection with the work of the chemist is to a large extent due to the nature of his pursuits. In the past, his labours have been carried out in an atmosphere of seclusion, but the war has brought him more into the open, and it is his duty to see that he maintains that position among the other professions which he has justly acquired, and that he becomes recognised as an essential factor in the industrial development of the country. Judging by the steady organization which is being quietly carried on all over the world by members of the profession, it appears that chemistry is not to be allowed to sink back into that obscurity which had hitherto hampered it.

Chemists, as a class, are apathetic, and many are content to stand aside and criticise the efforts of those who, having the interests of the profession at heart, are endeavouring to raise its status. The attitude of these critics is to stand aloof until they see material gain at hand, not realising that as the position of their fellows improves so must theirs also improve. Such an attitude is extremely selfish and unworthy of the profession.

An examination of the opportunities afforded to chemists in this country shows that the appointments available can be divided into three groups, viz., Government, Industries and Miscellaneous. I propose to examine these briefly.

The Government employs a considerable number of the members of the profession. According to the Civil Service List for 1918, no less than 28 chemists were in its employ, being divided into two departments, namely, the Department of the Interior and the Department of Agriculture, the former being in the sub-department of Public Health, and dealing with the matters concerning this department, and the latter with agriculture and agricultural education. When, however, we examine the pensionable emoluments offered to those in its service we can only come to the conclusion that these are far from being satisfactory.

In the Department of the Interior occasional appointments are made in the grade —laboratory assistants. The qualification required for this post is stated to be "A knowledge of chemistry." What this means admits of different interpretations. The salary is £125 rising by annual increments of £15 to £200 per annum, which might be sufficient for a bottle-washing apprentice, but is certainly not encouraging to the youth who has had an expensive professional training.

The next grade is termed "Second Grade Chemical Assistant." For this appointment a graduate of a University "with Honours "in Chemistry or a Fellow or Associate of "the Institute of Chemistry, with know-"ledge of the analysis of foods and drugs," is eligible, and the salary is the munificent (*sic*) one of £220 per annum arising by annual increments of £20 to £360 per annum.

The next grade, "First Grade Chemical Assistant," is usually filled by promotion, as is to be expected, though this is not always the case as was shown by a recent advertisement. The salary attached to this post is £380 with annual increments of £20 to £440 per annum, and this is the plum of the profession forsooth!

In view of the qualifications and experience demanded, an applicant for an appointment as second grade chemical assistant cannot be under 23 years of age, and if his application is successful and he receives the appointment, then at the age of 30 a generous Government pays a tried and trusty servant the stupendous salary of £30 per month.

There he remains praying for the retirement or death of the man above him.

A comparison between the qualifications demanded of these "second grade" men and those of the highly paid departmental clerks who draft these advertisements would be an odious one.

A summary of the pensionable emoluments in the respective grades is interesting and at the same time instructive:—

Public Health Department, Laboratories.

Government analysts, three receiving £460 to £850.

Assistant analysts, two receiving £550.

First grade chemical assistants, five receiving £380 to £450.

Second grade chemical assistants, six receiving £220 to £360.

On turning to the Agricultural Department the position is quite as disheartening. The chemical appointments, which number 11, may be divided into three classes, as follows:—

a. Veterinary Research, one receiving £700 per annum.

Agricultural research chemist, one receiving £650 per annum.

b. Agricultural Laboratory, Pretoria.

Assistant chemists, two receiving £380 per annum.

Second grade chemical assistant, one receiving £220 per annum.

c. Schools of Agriculture.

Lecturers in chemistry, four receiving £285 to £430 per annum.

Research chemists, two receiving £285 and £320 per annum.

Recently several Government advertisements have appeared in the local press for chemists in the Agricultural Department, for engineers in the Department of Mines and Industries and for a foreman carpenter in the Department of Lands.

A comparison of the qualifications required from applicants with the salaries attached to the position is not without humour.

Division of Chemistry, Department of Agriculture, Pretoria.

"Candidates should hold a university "degree (with honours in chemistry) and "possess a knowledge of agricultural and "analytical chemistry. The commencing "salary is at the rate of £300 per annum, "rising by annual increments of £20 to "£400 per annum."

Assistant Chemists at the Schools of Agriculture.

"Candidates should have graduated in "science and specialised in chemistry, or "possess qualifications regarded as equivalent to such a degree. Officers appointed "will be required to assist the lecturer in "chemistry in connection with the instruction of students and in experimental and "analytical work. The commencing salary "is at the rate of £240 per annum rising by "annual increments of £15 to £300 per "annum."

Assistant Inspectors of Mechinery, Department of Mines and Industries.

"The commencing salary attached to "each post is £400 per annum, rising, subject to satisfactory service, to £500. . . . "Candidates must have had a thorough "training in theoretical and practical "engineering, and possess a good knowledge "of electrical engineering."

Foreman Carpenter, Department of Lands.

"Applicants must be capable to take "charge of and supervise the erection of "buildings. Salary, £40 per month."

A local association of chemists some time ago took exception to an advertisement issued by the Department of Defence in which members of the profession were classfied with blacksmiths, carpenters and other tradesmen. A heated press correspondence took place carried on chiefly by partisans of the carpenter in which they stated that there should have been no protest by the chemist. Judging from the salaries offered in the advertisements which I have quoted, the carpenters should not have claimed equality, but superiority. The advertisements also supply the answer to the question: "What shall we do with our boys?"

It will be generally admitted that the Government is not giving a "fair deal" to the chemist. The offer of such emoluments to men who must be so highly trained as the chemist is certainly a reflection on the intelligence of those who offer them. The chemist is surely entitled to a salary which is at least comparable to that given to the artisan and the time and money spent in acquiring the necessary training should also be taken into account.

I hold no brief for the unfortunate Civil Service employee, but the time has certainly arrived when such injustices must be remedied and the remuneration should be proportionate to the value of the chemists' services to the country. This lack of satisfactory recognition of scientific officers is common to all departments of the Civil Service, and it is not surprising to find that men who are of the greatest value to the country are being constantly enticed away by more remunerative offers from other Governments and private employers. This depletion has been the text of many scathing articles in the press, and the "penny wise and pound foolish" attitude of the Government has been condemned in forcible language.

The chemical industries are responsible for the employment of the next larger number of chemists, and unfortunately it cannot be said that the position in this case is particularly satisfactory either. It was the practice in pre-war days for many of these firms to import their chemists on contract. The salaries offered when examined from the oversea standpoint seemed alluring, but disillusionment was soon experienced on arrival in this country. Unfortunately, the alternative opportunities are so limited that the unlucky chemist was compelled to accept the unfair conditions. Under any circumstances, there are so many chemists being trained here nowadays that there should be no necessity for overseas importations.

Recently an industrial firm endeavoured to obtain the services of a chemist from England, and the inducement put forward was a salary of £200 per annum. It is gratifying to record a refusal of this generous offer. Another case I know of is in connection with a chemist who was brought out here on contract, his salary being kept at a low figure until a suitable opportunity came his way and he gave notice. A good increase was then offered him and he decided to remain, a decision he now regrets. His experience and qualifications are such that he is able to undertake, as well as supervise, practically all the technical operations conducted in this industry, and in the absence of any of the other officials he is called upon to undertake their duties as well as carry on his own work as chemist. Whereas the artisans employed in the factory have the usual 48 hours per week, he is compelled to do 12 hours daily and is frequently called upon to do night work. His contract also includes a pernicious clause preventing him from accepting a situation with any similar firm in the Union for three years after leaving his present situation. This, I believe, is illegal, but the firms in this particular branch of the industry are so closely related that he would be compelled to lose all the advantage of his previous experience and take a situation in some other branch of chemistry.

It seems that the vision of the industrial employer is, like the Government's, narrow and confined and they both fail to appreciate the fact that contentment leads to efficiency. As an instance of the mental outlook of the employer, I shall quote the case of one factory where well over a dozen chemists are employed, distributed throughout the factory and the laboratory. The laboratory, as is to be expected, controls the raw material and the output, but nevertheless those employed in it are graded on what is termed "non-productive work"!

The remaining or miscellaneous chemists are employed in the smaller industries (where the chemist is frequently called upon to act as a handyman), the various Universities and University Colleges, private and other laboratories and the mines. In most cases the salaries of the assistants are below that paid to artisans.

The question then arises as to the action to be adopted in an endeavour to raise the status and at the same time the emoluments of those who practise the profession of chemistry. To this matter I have given much thought, and I fear it can only be achieved by educating those who are in authority and the public to appreciate and understand the value and importance of the services rendered both directly and indirectly by the chemist. The Government and Government Departments, not only here but in Europe, are notoriously ignorant on scientific matters, and no opportunity should be lost of instructing the legal luminaries who determine our destinies about the many ways in which science is able to assist them.

It will necessarily be a slow undertaking, but I am satisfied that it can be done and if we, who are at present practising the profession, do not derive much benefit from it, those who follow will have reason to thank us for our perseverance on their behalf.

The profession will always be burdened by one great disadvantage, until such time as Government recognition is obtained, and that is the existence of the type of so-called chemist who acquires his knowledge by being apprenticed as a youth in a works or other laboratory where he obtains his practical knowledge: the theoretical portion, such as it is, being nominally acquired by attendance at evening classes. This system is entirely unsatisfactory and ultimately places on the market, in competition with fully qualified chemists, a man who is only partially trained and who, sometimes unfortunately, owing to his lack of knowledge, tends to bring discredit on the profession. I say most emphatically that, in this country at any rate, it is not yet possible to acquire an adequate knowledge of the profession by this means and the fond father whose son has achieved distinction in chemistry at school must be instructed in the proper manner in which a satisfactory knowledge of the profession of chemistry can be gained—without expecting his son to earn money too early. I admit that there are those who have been able to rise superior to their environment and the more honour to them, but they are the exception. The qualifications for a Government appointment nowadays, and rightly so, are such that only those who are fortunate enough to graduate at a University can hope to be successful and the tendency among private employers, especially in connection with the more remunerative posts is to demand a similar high standard.

The position of research in South Africa is disappointing it will be generally admitted. There are very few chemists in the Union who have the requisite time and adequate facilities for conducting a research of any magnitude.

In the Universities, where, taking an analogy with similar European seats of learning, we might expect to find some enthusiasm in this direction, it is disappointing to state that comparatively little research work is done. To those of us who are accustomed to home conditions where professorial appointments are largely made on the candidates reputation in research, the position, to say the least, seems peculiar. An improvement appears doubtful when we find that in the three years' course now required for the Bachelor of Science degree, no provision is made to instruct the student, even in the most modest fashion, in the methods of research. There does not seem to have been much original work done in connection with our industries, judging by the small number of publications presented to societies such as ours: however, the explanation may be that publication of such work may not be permitted.

In the Department of Agriculture there are four appointments which are graded as research chemists, one in the Veterinary Research branch, one in the Division of Chemistry, and two at Schools of Agriculture, the salaries of the latter being in 1918, as previously mentioned, £285 and £320 per annum. A contrast with the research activities of the Department of Agriculture in the United States of America is decidedly startling. In 1913, the United States had ten great scientific bureaus each actively prosecuting research in the different branches appertaining to agriculture; the sum spent on printing alone in this year amounted to approximately £100,000.

Further, there were no less than 64 experimental stations throughout the country each engaged in agricultural research chiefly relating to the neighbourhood in which it was established. Can we wonder at the frequent complaints made at every farmer's congress about the utter inadequacy of the Government staff to conduct fundamental investigations?

At the beginning of this year a Research Grant Board was constituted by the Government, and its decisions in connection with applications for research scholarships and grants-in-aid of research in respect of the year 1919 were recently announced.

A sum amounting to £1,650 has been allocated among 18 successful applicants, made up of 7 scholarships, amounting to £860, and 11 grants-in-aid of a value of £790. The position as regards chemistry in the list of awards is disappointing as only one deals with a chemical problem.

The Royal Society of South Africa also annually administers a research grant of a value which, while I have not the correct figures, does not exceed £1,000.

It will have been noticed recently that the British Government has established a department for scientific and industrial research, while a grant of £20,000 is being arranged for. This sum is to be expended in stimulating scientific research with a view to developing the economic resources of the Colonies and Protectorates during 1919 and 1920 and the four following years. The Union Government has been asked to furnish a brief review of the present position of affairs. It must unfortunately be necessarily a brief one!

The mineral industry of the Union is the accepted backbone of the country, and according to the recent reports of the Department of Mines and Industries the value of the mineral output during 1918 amounted to £47,737,738, made up chiefly of the following items:—

Gold	£35,759,003
Diamonds	7,114,867
Coal	3,224,597
Tin	440,995
Copper	342,105
Silver	187,608
Salt	163,722
Lime	158,245

The magnitude of these figures is sufficient excuse for a plea for the establishment of what may be termed a "Bureau of Mines," to be conducted on lines similar as far as applicable in this country to the institution of that name conducted under the Department of the Interior of the United States of America. This Bureau was established to conduct, in connection with the public welfare, fundamental inquiries into the mining, metallurgical and mineral industries. Those who have followed its labours know the importance and value of its investigations. In 1913, the money voted to it amounted to £132,400 of which approximately £70,000 was devoted to technical research pertinent to the mining industry.

A similar institution in this country would be responsible for enquiries of a like character, and would conduct research work in connections with problems, such as miner's phthisis. This subject has been considered by many Commissions as well as select Committees of the House of Assembly since 1904, but no real investigational work was carried out until 1912 when the Miner's Phthisis Prevention Committee, which consisted essentially of technical men was formed Commissions of necessity must consist of partisans, and the result is, that majority and minority reports are the rule and not the exception. The pronouncement of a body such as the Bureau on this and similar subjects supported by a mass of scientific data, would be of such a nature that its finding must be accepted and given effect to by legislation. Hinged closely on the question of phthisis, is the carrying out of the routine analyses necessary for the control of noxious gases and dust in mine air It is surely anomalous to find that such an important and vital matter is left entirely to the mine authorities, who, however, hedged round by regulations will not always, in the records which they are obliged to keep, reflect the true ventilation conditions of the mine if that be bad. I say this advisedly. The regulations lay down definite figures for the permissible limits of noxious gases, but I have yet to learn of prosecutions for non-observance, at any rate within the past few years The responsibility for the observance of the regulation lies with the Government, and it cannot shirk its responsibilities by placing the onus on the mine authorities. This obligation is accepted in connection with the other regulations, as is instanced by the appointment of mining and machinery inspectors.

The duties of the Geological Survey could most appropriately come under this Bureau, and would result in a great co-ordination of work

In 1914, in addressing you, Prof. Stanley urged that the Government should make provision for the conduct of metallurgical investigations of refractory ores and instanced the facilities which already existed for this purpose. Such investigatons could most suitably be carried out by the Bureau.

Many other instances where the Bureau would prove its usefulness must occur to you

As a rough outline of the method of working the Bureau I would suggest that it be divided into routine and research departments each under a deputy-director who would be directly responsible to the director in charge of the Bureau. The appointment of the staff would create no difficulties, but the emoluments offered should be of a nature that really competent men would be obtained.

As a scientific society we are deeply concerned in the question of education and, have shown in the past great interest in this matter. The formation of a University in our midst where facilities will be afforded for a comprehensive training in Science, Arts and Commerce is a matter for congratulation; and we welcome the donations which have been given towards this object, and look forward with confidence to the time when the example which has been set will be excelled by those whose wealth has been acquired by the application of scientific knowledge to the industries of the country. Cicero said, "What greater gift or better can we offer "to the state than if we teach and train "up youth?" These words are true today.

It is interesting to remark how donations and bequests to universities and other educational institutions have been given in other countries by those who have been able to appreciate and apply science to their business, and realise the necessity for its encouragement.

A donation of £218,750 was recently made to Cambridge University by members of the British Oil Companies for the purpose of the establishment of a definite and detailed course of education, particularly for chemical students. This satisfactory recognition of the value of chemistry is extremely gratifying and gives a lead to those who are indebted in a similar manner to science. We also learn that another bequest of £200,000 was made to the Queensland University by the late Sir Samuel McCaughey. The local example of the late Mr. Beit, whose bequest of £200,000, as we are all aware, was filched from us probably owing to our delay in dealing with it, should also act as a stimulus.

The nucleus of the university is here, and shall it be said that we were so neglectful of our own interests that we let it languish? Posterity will be our judge, and it is for those who have the wealth to ensure that the verdict will be a favourable one.

In the quarter-century which has elapsed since the formation of our Society, South Africa has advanced to a position which now enables her to take a worthy place among the nations of the world, and it is for us all to do our share in seeing that she maintains that proud position. It is our heritage won by the sacrifice of those who have gone, and it behoves us to do nothing to tarnish the lustre of their bequest but to make South Africa's position more secure, more prominent, more brilliant, and to pass on to our sons in our turn a talent which we have not buried.

As a Society, we can play a great part in the future industrial expansion of the country. Our record is bound up with the history and development of the gold mining industry, and is one of which we have cause to feel proud. There is no reason why in the future we should not take the same prominent part in other directions and in fostering other industries through chemical knowledge.

Mr. J. Chilton *(Vice-President):* I am sure we are all indebted to our President for his very eloquent address. It is very seldom that this meeting hears the Government receive such deserved criticism, but it appears to me the President has said something that ought to be said, and ought to have been said years ago. His remarks are so pointed that even our thick-skinned Government can hardly pass it over without putting up some defence. There is not the slightest doubt that our chemists, as a body, have been inarticulate, and have not made their united voice heard. If they had gone to the hustings like other bodies and aired their views to members of Parliament probably their conditions would have been a great deal better than they are to-day. They might take a lesson from others and engineer a strike or even threaten a strike, and their condition would receive attention. Of course it may be that the Government has the idea that as the chemist of to-day is the lineal descendant of the alchemist of the middle ages, whose chief work seemed to be the search for the philosopher's stone that would transmute base metal into gold, it thinks that this great discovery has been made, and that chemists can make gold for themselves so it is unnecessary to provide a decent salary!

In the future of this country, especially dealing with our coal products, there is a great field of activity for our chemists. In the coal fields of the Transvaal and Natal we have a great source of national wealth that is being absolutely wasted through bye-products not being utilized, and to these men who can increase our national wealth we offer a salary that a tramway man would scorn. If we had a few addresses such as we have just listened to, this state of things would be altered. I think there is a great debt due to Mr. Gray for bringing forward the cause of the chemists, and I have much pleasure in moving the vote of thanks.

Unfortunately the laws of the Medes and Persians which apply to this Society will not allow us at this meeting to discuss the address, but I am certain that wherever technical men meet this will be brought forward for discussion and appreciation.

Mr. C. J. Gray *(Member of Council):* I beg to second the vote of thanks to the President for his exceedingly interesting address. Not only the chemist, but members of other technical professions, also represented in the Society, will be glad to receive greater recognition.

The President: I have to thank Mr. Chilton and Mr. C. J. Gray for the manner in which they have proposed and seconded the vote of thanks, and you for the manner in which you have received the address.

THE SOLUBILITY OF GOLD IN CYANIDE SOLUTIONS.

By H. A. White (Member of Council).

(Printed in Journal, July, 1919.)

DISCUSSION.

The author introduced the paper, published in the July *Journal*, briefly summarising the main points.

Dr. James Moir *(Past-President)*: I rise to move a hearty vote of thanks to Mr. White for his very interesting paper. Although it has appeared in the *Journal*, I am sorry to say I have only had time to skim it, and do not wish to discuss it very fully, but I should emphasize that it was the author's previous work on oxygen in water that has enabled him to make this advance in dealing with the solubility of gold in cyanide solutions. If the early investigators like Maclaurin had had these data on oxygen, they would not have come to the erroneous conclusions they did come to. Evidently the solubility of gold does not depend on the cyanide at all; it depends on the oxygen. In a paper which I wrote many years ago, before the Science Association—I think in 1904—I pointed out—but of course I had no explanation at the time—that the solubility does not agree with Elsner's equation,

$$8KCy + 4Au + O_2 + 2H_2O = 4KAuCy_2 + 4KOH.$$

If that equation is true, then the solubility of gold is proportionate to the eighth power of the concentration or amount of cyanide, which of course is absurd from the experimental point of view. Probably there is only one important step in the process, viz., Au (uncharged) + (CN)' = AuCN (uncharged) + negative electron. Four negative electrons then attach themselves to uncharged oxygen, producing 2O', which with $2H_2O$ gives 4(OH)'.

I have much pleasure in moving a hearty vote of thanks.

The President: I am sure we are very much indebted to the busy metallurgist, Mr. White, who has found time for such extensive research work on the question of the solubility of gold in cyanide solutions, and I think his example should be brought to the notice of those who possibly have more facilities, and the result might be that we should have more papers of original merit placed before us. I have much pleasure in seconding the vote of thanks which Dr. Moir has proposed.

GOLD-ZINC-CYANIDE.

By W. R. Feldtmann (Past-President).

(Printed in Journal, August, 1919.)

DISCUSSION.

The President: Unfortunately Dr. Caldecott, who was to introduce this paper, has been called away at the last moment, and therefore has been unable to do so.

I think we have reason to feel proud that we have not been forgotten by our Past-President: Mr. Feldtmann was the President of the Society in 1896-7, and about that time I think was a prolific contributor to our proceedings. It is very satisfactory to us to find that he maintains his interest even after so long a date, and comes forward with a contribution that is worthy of emulation by our other Past Presidents who have left us. I would like to propose a very hearty vote of thanks to Mr. Feldtmann for his paper.

Dr. W. A. Caldecott *(Past-President)*: Our Society is fortunate in securing this contribution on a very interesting chemical compound from one of its earliest members and a Past-President of twenty-two years' standing.

The existence of zinc cyanide in zinc box precipitate is known,* and also the existence of aurous zinc cyanide. In Comey's "Dictionary of Solubilities" (p. 142), zinc gold cyanide is described as being nearly insoluble in hot or cold water, and insoluble in cold aqueous hydrochloric acid. I am not aware, however, that prior to the author's discovery the presence of zinc gold cyanide in zinc gold slime had been suspected, nor its properties and crystalline forms determined. Zinc gold cyanide appears to be the zinc salt of aurocyanhydric acid, $HAuCy_2$, and its composition may be expressed as $Zn(AuCy_2)_2$, thus showing its analogy to the corresponding cuprous and silver salts, $Cu_2(AuCy_2)_2$ and $Ag(AuCy_2)$.

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*"Rand Metallurgical Practice," Vol. I, p. 390.

BWANA M'KUBWA COPPER MINE—NORTHERN RHODESIA.

By E. M. Weston (Member of Council).

This property is situated on the Katanga Junction railway, about 100 miles north from Broken Hill and about 30 miles from the border of the Congo. The outcrop of the ore body runs along the top and east side of a kopje, about half a mile long and 100 ft. high. This kopje is of a rock locally known as sandstone; but is probably a porphyry with quartz ground mass and felspar crystals. This shows green stains of malachite, and above ground level is leached and carried 2% to 3% copper. The ore body is about 1,600 ft. long, reef to 100 ft. in width. As the water level is 240 ft. below ground level, leaching and in places secondary enrichment, has been much in evidence, and a central richer vein has yielded those well-known beautiful specimens of mamillary malachite. Towards water level bornite, high grade chalcopyrite and grey copper ore begin to appear, and below water level these ores prevail. The central ore body has been largely stoped, and about 50,000 tons of ore averaging about 12% copper have been milled. This was roughly hand-picked and concentrated on jigs and Wilfley tables in a small 100 ton a day mill. Owing to the character of the ore over 50% of the copper was sent to the dump in the slime and sand. A concentrate of 40% copper was calcined and sent to Europe. High rail freights and the expense of coke and fluxes make smelting locally the bulk of the ore body, which has a value in the vicinity of 5% copper, almost impossible and the problem presented itself of making available the large tonnage of copper in this ore body. Oil flotation in the hands of the Mineral Separation Co. has made great progress in dealing with many classes of ore not generally considered suitable for this process. Exhaustive tests were made in London with flotation, and as a result a process was devised which gave excellent results with large parcels.

Following this, the small mill has been remodelled, a Hardinge mill installed for fine grinding and a flotation unit added, with which bulk trials of the mine ore are being made. It is expected to make a concentrate going over 20% copper.

It is not stated what process is being employed to make the malachite float.

I am indebted to the Manager, Mr. Wiley, for a most courteous reception and these notes which I trust will prove of interest to members.

The concentration of low grade oxidized ores of copper has always presented an insoluble problem unless leaching processes were practicable and the success of flotation methods for this class of ore is of great interest and importance. Perhaps Mr. Wiley will be able to give fuller particulars at a later date.

The President: I am sure we are extremely indebted to the author for his interesting note, and I hope that his wish regarding Mr. Wiley will be fulfilled.

Mr. J. Allan Woodburn *(Associate):* I have great pleasure in seconding the vote of thanks to the author. I think anybody dealing with base metals should contribute notes similar to the author's, because they render available a little more information to this Society. I believe that at a very early date refined copper will be produced in the Transvaal, and I think that may lead to further industries. There is no reason why copper should not be drawn into wire for construction and electric transmission locally, and, as time goes on, if communications with distant mines is improved, then Central Reduction Works might enable quite a number of small mines to open up and work, which, at present, it is impossible to bring to a producing stage. I believe investigations have also been made recently with regard to metallurgical work of that description, and someone has been recently in the country who has suggested that both in Rhodesia and in the Transvaal there might be openings for reduction works of that sort. I think if a little more information were given, such as the author has notified, it would all help towards the end which we all wish to see.

Prof. G. H. Stanley *(Past-President):* I would like to ask if the author of the paper would state what percentage recovery is obtained? On some of this, or at any rate very similar ore, I tried a good many processes of concentration, and in some cases obtained a pretty high concentrate, but the percentage of concentration in all cases was quite unsatisfactory. It is very difficult ore indeed to treat, and if flotation can be successfully applied to these low grade copper ores, it marks a very great advance.

Mr. J. Gibson *(Associate):* The author of the paper has confined his attention more or less to the metallurgical side and the treatment of ore, but those who are interested in the history of the Katanga Copper Mines will find a very excellent paper in the transactions of the Geological Society of South Africa (Vol. XVI), by Mr. F. E. Studt, published in 1913, which gives a very comprehensive view of the whole of the geology, not only in that particular district, but in the whole of the Belgian Congo, and also of Rhodesia. It is very interesting to learn from his notes, that all these copper ores occur in what is known as the dolomite formation of the Transvaal system, a system which appears at intervals from Bechuanaland extending away north, and the most northerly portions in the Congo basin are of very great extent. Most of these copper veins I believe occur in the dolomite formation, practically identical with that what we have appearing in the Eastern and Western Districts of the Transvaal, and it would appear that the formation is going geologically to prove a most important one for the future of South and Central Africa. The beds are folded into a series of anticlinal and synclinal folds across which the fissures containing the copper and other ores extend, and the cause of both the fissures themselves and their mineralisation will probably be found to be the intrusion of the granite masses which exist along the southern margin of what is now known as the Katanga copper belt for a length of about 250 miles, approximately parallel to the watershed between the Congo and Zambesi basins.

Further exploration and prospecting will thus doubtless reveal the existence within this area of other fissures besides those already discovered.

Mr. H. R. Adam *(Member of Council):* There is one point in connection with the author's paper I might draw attention to. The preliminary testing work on this and on many other ores has to be done in London. When the President's suggested Bureau of Mines is established we may expect such work to be done in Johannesburg.

ANCIENT TIN MINES OF THE TRANSVAAL.

By Max Baumann (Member).

(Printed in Journal, February, 1919.)

REPLY TO DISCUSSION.

The President: The author has come down from Rooiberg to give a reply to the discussion on one of the most interesting papers we have had read before the Society for some years, and I am sure we shall get something very enjoyable from him in connection with his reply.

Mr. Max Baumann *(Member):* The discussion on this paper has brought out but few fresh technical facts, the contributors to the discussion devoting themselves mainly to the historical aspect of the case.

Quite recently another old working on the "H" lode at Rooiberg was holed into at a depth of 50 ft. below surface. There was no outcrop evidence of a working below except for a very large marula, which tree loves to send its roots deep down and has been found locally to be a good indication.

This working, like the one illustrated on p. 125 of the Feb., 1919, *Journal*, was filled with waterborne sand. The interesting point is, that this sand carries 0·7 to 1·0 % metallic tin. The working has not yet been cleaned out but since the ordinary surface sand, which is now being treated for tin, only averages 0·15 % metallic tin (3 lb. per ton), it is probable that this working may have been used like some others for the disposal of ancient tailings.

On the question of illumination, I have been informed that in the ancient workings at Weynek, small lamps were discovered. These were of common earthenware and resembled in size and shape the truncated spherical coffee cups in use on the dining cars of the South African Railways. It is stated that these lamps contained wicks made out of the fibrous monkey tail or "bobijaan stert" (Barbacenia Retinaria, Baker Bax). My informant was not aware at the time of the value of this evidence and paid no great attention to the matter. The information is therefore not over reliable, but if correct would show that the Weynek workings must have been of very recent date for the monkey tail fibre is not a substance that would be likely to last for any length of time, and would disprove Theal's statement that the Bantu were not acquainted with lamps.

A point has been made of the fact that few workings both here and in other parts of South Africa bear any gad markings. Their absence can be explained, if it is assumed that the ground was mostly broken by the method of fire-setting. This has been proved experimentally as follows: An eye of ore a few inches in diameter surrounded by country rock (quartzite), *i.e.*, a miniature pocket, was brought up from underground and heated in a woodfire and when at a high temperature was suddenly quenched in water. Owing to the different co-efficients of expansion of ore and quartzite it was found that the former broke away clean from the latter leaving a cylindrical core of ore and a cast of the cylindrical pocket in quartzite.

Mr. C. J. Gray wishes to know, whether more recent investigation has shown the correctness of Mr. Jameson's statement that the ancients when they reached the limits of a pocket did not follow the line of fissuring in search of more tin. Although it is difficult to state definitely that they did not do so, everything tends to indicate that the ancients did no development in barren country or on thin non-ore-bearing fissures.

Mr. Trevor's contribution is a most valuable one, and is a paper in itself. He is in agreement with the writer that the greater workings from the Zambesi to the High Veld, *i.e.*, for gold, copper and tin are attributable to the same workers, though the actual work must certainly have extended over long periods of time. Mr. Trevor's estimate made in 1912 of 2,000—3,000 tons of metallic tin agrees with my own and Mr. Schoch, who has a very wide knowledge of the area under discussion, believes that this quantity is if anything an underestimate.

Mr. Waites, in two rambling contributions, under no circumstance will believe in the antiquity of the workings nor will he accept the late R. N. Hall as an authority.

The term "ancient" is after all merely relative and the antiquity of South Africa, Britain, Egypt and Chaldea are in an ascending scale of age. The word "ancient" as applied to mine workings in South Africa refers to those workings which were in operation before the dawn of history in South Africa. Now although Herodotus states, that under the Egyptian King Nechos, about 610 B.C. an expedition commanded by Phoenicians left the Red Sea and sailed round Africa returning after three years via the Pillars of Hercules (Straits of Gibraltar), nevertheless the first actual written record of Africa, south of the Zambesi, is that of the Arabian historian Massoude of 915 A.D. The writer takes it therefore that any event antecedent to that date may be assumed to be ancient. As regards Hall's opinion that the ancients were probably Semitic, the late Theodore Bent who was engaged in archaeological research in Asia Minor, S.E. Africa and Southern Arabia, concluded that the culture was originally introduced from Asia at some period of pre-Islamic times (see "Ruined Cities of Mashonaland"). The late Dr. G. M. Theal was another upholder of the Semitic or Sabean theory, and Dr. Livingstone states that Semitic customs noticeable among the natives (Rhodesian) are probably the remains of the secret arts which prevailed among the Arabs before Mahomet appeared (*Last Journals*, p. 218). It is unnecessary to extend the list of prominent archaeologists and ethnologists who have accepted this theory.

Mr. Waites appears to lose sight of the fact that not only Jews but Arabs, Phoenicians and Tyrians, etc., were Semites, and that Jews are not all either buyers of old clo' or directors of mining companies. His statement that "Jews never toiled neither did they spin" is untrue and unworthy of refutation. Mr. Waites is not satisfied with archaeological, ethnological and historical evidence, and wants a skull to be found before he will believe in the antiquity of the workings.

The finding of half a dozen skulls would not necessarily settle the question of the age of a working. It is quite conceivable that a very ancient skull might be found in a modern working and *vice-versa*. As a matter of fact, as Mr. Schoch pointed out, a skeleton with skull has actually been found. The skull is in a good state of preservation, and Dr. L. G. Irvine, who has seen it, thinks that it is probably the skull of a large baboon. One would not argue from this, that the workings were made by baboons, nor that the find of the jawbone of a quagga in another working proves that the ancients used animals for underground tramming.

Mr. Schoch believes that none of the tin workings are older than the Portuguese settlement of S.E. Africa (1505), and that these were made under their direction. Apart entirely from any proof that the Portuguese ever did any mining, and there is direct evidence to the contrary, the history of the Leeuwpoort-Rooiberg area cannot be read apart from the history of the Messina-Palabora copper workings and the Rhodesian gold workings. Some feasable explanation must be advanced as to what became of the 3,000 tons of tin, the tens of thousands of tons of copper and £75,000 000 worth of gold which has come out of old workings and which was certainly not exported during the Portuguese era (1505-1750). Mr. Schoch thinks that if the many early records had not been destroyed in the earthquake of Lisbon (A.D. 1755) proof would be found to support his contention.

Theal, however, in his "Records of South Africa" (VII. volumes), gives numerous references from both Arab and Portuguese writers to the effect that there was no extensive mining in the interior during the period 915 A.D. to 1750 A.D.

One of the earliest accounts of the East Coast of Africa is in the "Periplus of the Erythrean Sea" (80 B.C.) which mentions Rhapta—identified with the modern Kilwa—as a dependancy of Yemen or Saba in Southern Arabia. Massoude (915 A.D.) states that the natives of the land behind Sofala did not use for their own purposes the gold and the ivory with which the country abounded.

M'Wardy (957) wrote: "The most remarkable product of Sofala is its quantity of native gold in spite of which the natives adorn their persons with ornaments of *brass.*" Edrisi in the 12th century wrote to the same effect. From 900 A.D. onwards there are no Arab references to gold mining by Arabs in the interior or to any extensive export trade in gold though there are references to the tradition that at some far away back time the gold for Solomon's Temples was obtained from the hinterland (Rhodesia). In this connection it is interesting to record that at the time of the first Governorship of the Cape by Van Riebeek, the Dutch East India Company sent out an expedition from the Cape to look for these traditional mines.

In Theal's "Records" the Portuguese historians, Barbosa, M. Barret, Lopes, Dos Santos and Monclaros all emphasize that, (1) the Portuguese did no mining (2) that the natives had no use for gold and did no mining except a little alluvial washing, (3) the total amount of gold brought to the coast was very small.

The whole gold output of Mozambique was farmed between the years 1598 and 1611 for from £1,000 to £8,000. This would not point to a very important mining industry.

Father Dos Santos (1586), who worked as a missionary for eleven years at Mazoe (Rhodesia), gives a list of tools of native manufacture not one of which could be used as a mining tool.

Theal and Stow state that Bantu tradition can trace back for twelve, sixteen or even twenty generations, say, 300 to 400 years. Yet there is no native tradition of extensive mining locally.

And it should be remembered that there was intensive prospecting from the Boshof Mountains to far east of the Elandsberg and from north of the Zand River to a long way south of Leeuwpoort, an area of approximately 200 square miles.

In 50 years of an exceptionally varied experience of all parts of South Africa, Mr. Trevor has only met with the Mapalacata tradition and has only found one bronze and one tin ornament of undoubted native manufacture. All other ornaments as he shows are of brass, and the question as to where the zinc for the latter came from is an interesting puzzle of its own.

Mr. C. J. Gray makes reference to an extract from Isaac's "Eastern Africa," published in 1825, which contains the story that some years previously the natives (Zulus) had dug a mineral which smelted to a glossy white metal. Ornaments made from this metal—presumably tin—were worn as rank marks by the chiefs until an epidemic broke out when the ornaments were declared to be "Umtagati" by the witch doctors. It is evident that if tin was a metal well known to or traditionally used by the Bantu, evil powers would not have been ascribed to it.

Finally, the point has been made that a Semitic race would have left some sort of inscription in or on their buildings or workings. The late Robert Hunt, F.R.S., the Keeper of the Mining Records, estimated that up to the birth of Christ 50,000 tons of metallic tin were taken out of the Cornish mines. The miners and seafarers were Phoenicians, a Semitic race, yet they left no records in Cornwall nor for the matter of that in Spain, where they mined largely. The tin ingot mould, astragalus, used by them in Cornwall was of a peculiar shape, it is surely more than a coincidence that gold ingot moulds in soapstone of precisely similar shape should have been recovered from Zimbabwe Ruins.

To sum up, the writer believes:—

(1) That the ancient tin mines were contemporaneous with the ancient copper mines of Northern Transvaal and the ancient gold mines of Rhodesia and the ruins in the latter country.

(2) That the mines were worked by, through or under the direction of a Semitic race who entered into Africa from Southern Arabia.

(3) That there was sporadic mining to a slight extent up to quite recent times by the Bantu but that the bulk of the ore was extracted at some period antecedent to the rise of Mohammed (600 A.D.).

A SAFETY FIRST METHOD FOR THE ESTIMATION OF CO_2 IN MINE AIR.

By H. R. S. Wilkes (Member).

(Printed in Journal, May, 1919.)

DISCUSSION.

Dr. James Moir *(Past-President)*: The only useful thing I can say with regard to this paper at present is that I think the author might have acknowledged the previous work on this subject. As printed, it appears as if it were an entirely original invention, which I think is hardly fair. The method of using a shaking bottle was introduced by Mr. E. A. Mann, Government Analyst of Western Australia, about fifteen years ago.

Mr. H. A. White *(Member of Council)*: I think Dr. Moir's modesty prevents his adding that he himself arranged a suitable modification, and a very valuable one, which I believe was in use for a very long time, and I believe is still in use in some of our mines.

The President: It is quite probable the author did not know of this at the time he wrote the paper, and I have no doubt he will be pleased to give suitable acknowledgment.

Mr. H. R. S. Wilkes *(Member)*: I may say that your remarks with regard to my lack of knowledge of this process of Dr. Moir's are quite correct, but in my notes I did not claim any originality; in fact, the first paragraph gave the credit of the idea to Professor le Neve Foster who suggested the method in Cornwall—some 35 years ago, and I definitely stated that in my paper. I do not claim any originality at all, except for the style in which the method is presented. The application of the chemical reactions involved I claim no originality for. I think 35 years ago pre-dates Dr. Moir's method.

The meeting then terminated.

Notices and Abstracts of Articles and Papers.

CHEMISTRY.

Interferometer in Gas Analysis.—"A recent technical paper issued by the U.S. Bureau of Mines, describes the outcome of some of the investigations made by the Bureau in connection with work on mine gases and natural gas. For special work in the field of gas analysis some of the older analytical methods have been partly supplanted by those that permit analyses at frequent intervals. The Rayleigh interferometer, as adapted to gas analysis by Fritz Haber and Frederick Lowe, of Jena, meets this requirement. It makes use of the optical properties of gases and is suitable for analysing a binary gas mixture. The outgoing air currents from mines contain carbon dioxide and methane mixed with air. A decrease in the amount of oxygen and a corresponding increase in the amount of nitrogen are indicated by the interferometer as an increase in the methane and carbon dioxide content. Hence, regardless of the cause of contamination of the air, by the addition of methane or carbon dioxide, or the withdrawal of oxygen, the instrument indicates imperfect ventilation. The instrument may also be used to detect the contamination of hydrogen with heavy gases such as oxygen and nitrogen. This use should be of especial importance in determining the power of gases to carry aircraft. If air is assumed to be the contaminating gas and if pure hydrogen is used as the standard of comparison, the sensibility is 0·02%. A third use of the interferometer is in determining the degree of carburisation of illuminating gas carburetted with benzol. A sensibility of 0·1 gm. per cubic metre is to be expected in this case. Another application is the determination of ammonia in distillation gases. Available data show that in this determination the instrument may be made to show a sensibility of 0·3 gm. per cubic metre. A common task in gas analysis is the determination of the composition of smoke and flue gases for the purpose of boiler control. One of the chemists of the Bureau is applying the interferometer to this problem and a complete report of his results will be published in due course. The interferometer may also be used to determine the efficiency of a given system of ventilation; in the control of mixtures of natural gas and air used in galleries for testing the safety of explosives; and in ascertaining the character of mixtures of sulphur dioxide and carbon dioxide resulting from organic oxidations.

The interferometer is made in two different models. A laboratory type, described in this paper, has gas chambers 1 metre long and is employed for exact gas analysis; its precision is equivalent to that of ordinary volumetric gas-analysis apparatus which use mercury as the confining fluid and give results accurate within 0·02% to 0·03%. The other model, a short or portable type, is employed for analysis of gas mixtures when less accuracy is desired. Its accuracy is comparable with that usually obtained in technical gas analysis when water is used as the confining fluid—that is, 0·20 to 0·30% of carbon dioxide or methane. In both instruments the principle is the same, the smaller type differing in details essential to portability. The short type when in position is upright; it is about 4 in. in diameter and 20 in. high, and weighs about 11 lb. Its use, like that of the laboratory type, is confined to binary gas mixtures."—F. M. Seibert and W. C. Harpster.—*Iron and Coal Trades Review*, March 14, 1919, p. 326. (J. A. W.)

THE LAWRENCE SMITH METHOD FOR THE DETERMINATION OF THE ALKALIES IN SILICATES.—"The material employed for the experiments was a sample of orthoclase from St. Gothard containing 12·39% K_2O and 1·78% Na_2O. Carrying out the heating under perfect control in an electric furnace showed that a minimum temperature of 700° is necessary for complete decomposition, although decomposition actually begins below 450°. The minimum time required at 700° is two hours. Heating for only one hour gives a yield of approximately 90% of the total alkalies present. The minimum quantity of $CaCO_3$ required to produce complete decomposition is six parts to one part of silicate. Less than six parts results in more or less residue insoluble in HCl. Throughout one part of NH_4Cl was added for one part of silicate."—P. WENGER and ED. BRANGE, *Mon. sci.*, 8, 97-9 (1918).—*Chemical Abstracts*, Sept. 10, 1918, p. 1735. (J. G.)

ESTIMATION OF PHOSPHORIC ACID, A MODIFICATION OF THE CITRATE METHOD.—"To avoid the intermediate precipitation of H_3PO_4 by molybdic acid, the author proposes a method for the analysis of fertilisers, ashes, etc., in which the Ca is precipitated as oxalate from an AcOH solution, and, after the removal of the Ca oxalate, the H_3PO_4 is precipitated in the usual way as $MgNH_4PO_4$, citric acid being added to prevent precipitation of Fe and Al. Treat the HCl solution (or other solution) of the substance under examination with a few drops of methyl orange solution and an excess of NH_4 oxalate solution, and add saturated NH_4 acetate or Na acetate solution until the colour of the indicator changes from red to yellow; then dilute the mixture to 100 cc., mix and filter through a kieselguhr filter. Mix an aliquot portion of the filtrate with 5 cc. of 20% citric acid solution and precipitate the H_3PO_4 with magnesia mixture."—J. GROSSFELD, *Z. anal. Chem.*, 57, 28-33 (1918); *J. Chem. Soc.*, *114*, II., 129.—*Chemical Abstracts*, Sept. 10, 1918, p. 1743. (J. G.)

DIFFUSION OF OXYGEN THROUGH COAL PILES.—"Mr. S. H. Katz, in a recent technical paper, published by the U.S. Bureau of Mines, gives an account of some research work on the subject of the rate of diffusion of oxygen through coal, which forms part of an extended investigation of the conditions affecting deterioration and spontaneous combustion of stored coal taken in hand by the Bureau under the direction of their former chemical engineer. The experiments described were carried out in an attempt to determine the effects of the size of coal and the proportion of voids in a pile on the rate at which oxygen can be brought by diffusion from the air around the pile to the coal within, the purpose being to discover the bearing of diffusion on the rate of spontaneous heating within the pile. When coal is stored the loss of oxygen in the air within the mass, through oxidation of the coal, causes oxygen from the outside to enter by both convection and diffusion, thus providing the means for further oxidation. The amount of oxidation from diffusion while air is entering by convection will vary with the magnitude of the convection. Hence the amount of oxidation that may be attributed to either convection or diffusion will differ greatly with conditions. Under some circumstances, air supplied by convection may act as the main source of deterioration and spontaneous combustion in stored coal; but the author considers only diffusion and its effects. The results of the experiments show specially the importance of the proportion of voids in a mass of stored coal exposed to the air in determining the possible amount of oxidation through oxygen entering the mass by diffusion. The amount of voids in any mixture of coal pieces can be kept low by having the large and small size coal uniformly mixed. In a mass of broken coal, through which oxygen is diffusing, the size of the pieces has (within practicable limits) no effect on the rate of diffusion, all other conditions being constant. The amount of oxygen diffusing through the interstices in a mass of coal pieces, seems to vary inversely as the depth of the coal. Sufficient experiments to justify a more definite conclusion than this have not been made. Coal stored in lumps or smaller pieces of uniform size contains a high proportion of voids, and oxygen diffuses readily through the mass. Mixing different sized pieces in a mass tends to reduce the proportion of voids. In storing coal in the air, factors other than diffusion may be accelerated or retarded by changes in voids; but if diffusion alone be considered, mixing the sizes of coal will reduce the oxygen entering the pile by diffusion. The building of a coalpile so as to reduce or prevent segregation of the large and the small pieces will lessen the proportion of voids in the pile, will tend to keep down the amount of oxygen entering the pile by diffusion, and thus reduce oxidation from this source."—S. H. KATZ.—*Iron and Coal Trades Review*, Dec. 6, 1918, p. 631. (J. A. W.)

A NEW SOURCE OF SULPHURIC ACID AND CEMENT.—"Investigations recently carried out in Germany have resulted in the establishment of a works for the manufacture of sulphuric acid and cement from gypsum by heating the latter with clay in a cement kiln. The products are a compound of the calcium in the gypsum with the silica and alumina in the clay, and sulphur dioxide which is converted in the usual manner by catalysis into sulphuric acid (*Tonindustrie-Zeit.*, Sept. 3, 1918). The process has an interest apart from the normal production of sulphuric acid, inasmuch as there are several sources of waste material which are rich in gypsum, plaster of Paris, and other forms of calcium sulphate yet cannot be made into plaster by the ordinary method of manufacture, and so are of little or no commercial value. For example, the old and broken moulds used in the potteries form large heaps around certain works and are quite useless because of the salts and absorbed clay present. If the new process is applicable on a moderate scale, it might prove to be an excellent means of ridding potteries and certain other works of an accumulation of material which is a source of expense and inconvenience. It would, of course, be necessary to investigate the matter fully from this special point of view before undertaking the utilisation of waste gypsum and similar materials on a large scale."—*Journal of the Society of Chemical Industry*, Oct. 15, 1918, p. 378R. (A. W.)

HYPOCHLORITES IN DRINKING WATERS.—"Treatment of drinking water with hypochlorite converts the ammonia and amino compounds present into chloramine and chloramino derivatives, and does not reduce the ammonia and albuminoid ammonia content as determined by the Nessler method. The fact that the chlorine in chloramines liberates iodine from potassium iodide may be used to ascertain whether a water containing much nitrogenous matter has been treated with hypochlorite. Fifty cc. of the water and 50 cc. of distilled water are placed in two cylinders and each treated with 1 cc. of $N/1$ sulphuric acid and 0·1 gm. of potassium iodide. If the water has been treated with hypochlorite a brown coloration develops, whilst the distilled water will remain colourless. Nitrites, which also liberate iodine from potassium iodide, would have been oxidized by the hypochlorite."—A. R. Ling, *Analyst*, 1918, *43*, 347-348.—*Journal of the Society of Chemical Industy,*, Nov. 30, 1918, p. 713a. (J. A. W.)

METALLURGY.

Effect of Air in Cyaniding.—"Since the general acceptance of Elsner's equation,

$$(2Au+4KCy.+O+H_2O=2KAuCy_2+2KOH),$$

there has been little controversy opposed to that deduction. MacArthur, one of the inventors of the first successful cyanide process for treating gold and silver ores, denied the supposition as to the necessity for the presence of air, or, rather, oxygen. In analyzing the reactions one finds that gold in a cyanide solution has a higher affinity for cyanogen than has potassium, but it cannot exercise that affinity unless some element is present in the solution to combine with the potassium which would be freed by the gold. This desirable element is oxygen, which combines with the potassium to form its oxide, K_2O. To complete the reaction and fulfill the equation, the oxide combines with water, H_2O, to form $2KOH$. The gold cyanide, insoluble in water alone, dissolves in the solution of $2KCy$ to form $2KAuCy_2$. Thus is evolved the complete term of the second part of the equation.

The foregoing synopsis is elementary, but basic to the consideration of the complicated conditions of actual practice in the treatment of auriferous ores which are crushed and pulverized to expose the maximum surficial area to the solution of KCy or NaCy. As tests are generally expressed in terms of KCy, and as NaCy is analogous in action with the former, this consideration and analysis will deal exclusively with the formula KCy.

Consideration will first be directed to the least-complex auriferous ores, consisting in the main of quartz containing, besides gold and silver, variable quantities (say 1% in the aggregate) of sulphides of iron, copper, and lead, which are pulverized in water or cyanide solution to which lime is added. In the grinding operation finely divided iron is introduced into the pulp. Much air is occluded in the solution during the grinding and subsequent agitation. Slimes are agitated in the cyanide solution by mechanical methods, such as stirring, or pumping from vat to vat. Agitation by compressed air is also extensively practiced, on account of the cheapness of that process, but mainly because the air provides the oxygen which is necessary for the reactions called for according to the Elsner equation.

Oxygen to promote solution of gold and silver has been supplied by the addition of oxidizing chemicals, such as permanganate, $KMnO_4$, ferricyanide of potassium, K_3FeCy_6, or MnO_2, BaO_2, or PbO_2. The use of these 'cyanicides' in practical operations has been abandoned in most instances, because of cost, inefficiency, and destructive effects Under ordinary temperatures and atmospheric pressure, quiescent cyanide solutions absorb air slowly and in insufficient quantity for speedy cyaniding of gold. But in motion under pressure the compressed air used in agitation insures a greater absorption of oxygen.

Heretofore the equation expressing the reactions of gold-cyanide precipitation has been written as follows:

$$KAuCy_2+2KCy+Zn+H_2O=$$
$$Au+K_2ZnCy_4+KOH+H.$$

But this latter equation does not express all the reactions, such as are due to the presence of excess of zinc and of water. In this precipitation there is always present a large excess of both water and zinc, and oxidation by decomposition of water by the zinc will continue as long as free potassium hydrate is present to dissolve the zinc oxide formed on the surface of the zinc. The presence of oxygen in the occluded air increases the oxidation and solution and is largely responsible for the accompanying waste.

As soon as there is no more solvent for zinc oxide, the precipitation of gold on the zinc ceases, because the surface becomes coated by a film of zinc oxide which isolates the gold from the metallic zinc on which it was deposited. This isolator insulates the gold by reason of the loss of essential galvanic, or electric, contact with the zinc. When this last condition prevails, and occluded air is present, the gold precipitate is dissolved by the cyanide solution. Of course this is not a necessary condition, but it frequently happens through ignorance or neglect. If no free oxygen be present, gold will not be thus re-dissolved.

A considerable number of investigators have studied the question as to the composition of white precipitate, and there is a wide divergence in opinion as to its origin and constitution. This divergence is probably due to the variety and composition of the ores being treated. The remedial addition of cyanide necessitates increased wastage of both cyanide and zinc.

A recently issued United States patent, which claims a monopoly for the practice of removing occluded air and gases from cyanide solutions before precipitation, draws attention to the fact that air has been removed from cyanide solutions as they pass to precipitation by various means, especially by pumps, including wet or dry vacuum, singly or in arrangement with vacuum chambers in various combinations, for many years, and at many times and places. This statement may be confirmed by examination of descriptions of cyanide plants published in books on the art, and in the transactions of technical societies devoted to mining and metallurgy. One citation is illustrative: *Trans.* A. I. M. E., Vol. 42, 1912, pp. 729-731.

The practice in the U.S. Patent Office which has prevailed during many years in the examination as to novelty of applications, has been to ignore the facts as to the prior state of the art involved, as shown in technical publications, other than patents previously issued by the United States, Great Britain, France and Germany. Therefore many patents have been granted which have not been sustained by the courts because of lack of novelty. This has caused much costly litigation which would have been avoided had the Patent Office functioned under a different system.

The practice of removing air from liquids is an old one and has been extensively adopted. The object has been effected by the use of such apparatus as wet or dry vacuum pumps, vacuum chambers, jets or sprays, in various arrangements or combinations, and barometric discharge pipes from vacuum chambers or vats. During the empirical development of the art, much apparatus and many methods were tried in the search for improvement. These were frequently changed, intermixed, or abandoned, without always selecting the best for continued practice. An example of this is seen in the adoption of air lifts to convey solution from vats to precipitation boxes, without a realization of the deleterious action of excess of air at this stage of the process. It has been satisfactorily and practically demonstrated in many large cyanide mills that the removal of air from cyanide solutions, before precipitation, results in considerable savings of both cyanide and zinc."—N. S. KEITH.—*Engineering and Mining Journal*, March 22, 1919, pp. 522-3. (H. A. W.)

METALLURGY OF GOLD AND SILVER.—"Under war conditions technological progress has not been so vigorous as it might have been, but, at the same time, it is difficult to review the year 1918 without noting that gold metallurgists are alive to the need of keeping abreast of the times, and that sufficient enterprise and initiative exist to counteract any *laissez faire* policy. It is notable that a broader view is now being taken of the activities in other countries; and the brotherhood of arms which was recently consummated between the representatives of the world's principal gold- and silver-producing countries, on the European battlefields, will doubtless persist in the form of a welcome catholicity of view as regards foreign practice.

New Records for Efficiency.—The results for the year ended March 31, 1918, at the plant of the Dome Mines Co., Ltd., Porcupine, Canada, are of exceptional interest. The tonnage milled amounted to 217,000, and, whereas the gold in the head sample was worth only $4.272, $4.173 was recovered as amalgamation and cyanide bullion. This showed an actual recovery of 97·676%, and a loss in residue of less than 10c. per ton. Although there is little justification for detracting from such an excellent showing, the question of economic limit of fine grinding in cyaniding might be raised.

Cyanide consumption is being reduced to an almost unbelievable point in some plants. The results at the Victor mill of the Portland Gold Mining Co. for six months of 1917 indicate that the amount of NaCN used has been lowered to 0·175 lb per ton of ore. This is a creditable showing, and close to the record for the City Deep plant, at Johannesburg, for the month of August, 1917, when a consumption of 0·169 lb. per ton treated was recorded. High zinc consumption usually accompanies high cyanide consumption. Economies are, likewise, usually in synchronism. The Portland company's showing of 0·191 lb. of zinc dust per ton of ore treated exhibits a considerable saving as a result of the introduction of the Crowe modification.

Amalgamation Practice.—Practically nothing new was evolved during 1918, although various minor economies have been effected in certain districts.

The relation of amalgamation to cyaniding has been discussed at length; and interesting notes have been published on amalgamation practice and economies, grease amalgamation of gold, and other phases of treatment.

South African Metallurgical Progress.—South African practice at the principal gold mining area—the Rand—has been standard for many years, and few modifications have been made. The primary method of gold recovery is by amalgamation, and the percentage of the metal obtained by this system has not been decreasing during recent years, despite positive statements to the contrary.

The outstanding feature of metallurgical practice on the Rand is the retention of the original method of milling in alkaline water, which permits such a comparatively high recovery of gold by amalgamation, and leaves a tailing in ideal condition for cyanide treatment. A further characteristic of procedure in this important district is the recogniton of the cheapness of leaching large tonnages of comparatively finely ground ore in open vats.

Statistics show that minor improvements in operation are constantly being effected, one of the largest groups, controlling a number of important mines, reporting reduced gold content in residue, with increased actual recovery, of 97%, being obtained from comparatively low-grade ores without the adoption of sliming.

It is a testimony to the soundness of the fundamentals of Rand metallurgical practice that the district has more than held its own during the recent war crisis, its proportionate contribution to the world's supply of gold having risen steadily, in spite of all disabilities, from 38·3% in 1914 to 12·58% in 1917. When statistics are available it will probably be found that the last-named figure has been maintained or exceeded in 1918.

The Reinstatement of Charcoal as a Precipitant.—The difficulty in obtaining supplies in isolated districts, and the increased cost of the necessary materials, have led to the achievement of many economies, and to the exercise of not a little ingenuity among cyanide engineers. One of the most interesting developments in the metallurgy of gold, chronicled during 1918, referred to the recognition of charcoal as a precipitant, and its resurrection from the obscurity to which it had been assigned for many years. This was achieved by the adoption of a new method of application, which has insured success. Briefly stated, it was found by the investigators that precipitating efficiency increased with fine grinding. The precipitant was therefore slimed in a ball mill, and formed into cakes on the leaves of a miniature filter of the Butters type, through which the pregnant solution was sucked by vacuum. In several instances the installation of the new method, in place of a zinc-precipitating process, resulted in an improved extraction of gold from the solution, together with reduced operating costs. Its wide application is doubted, as, up to the present, it has been found unsuitable as a precipitant for silver. It is probable, however, that further investigation may indicate the feasibility of using it prior to zinc or aluminium precipitation or as a substitute for either, in the case of silver-gold or gold-silver ores.

Gold Extraction with Colloidal Carbon.—Perennial interest is displayed in the possibility of abstracting the gold which occurs in minute quantities in sea water; but all schemes to this end have been classed with the numerous suggestions for the insuring of perpetual motion without external influence or aid, and other 'woolly' ideas.

A recent patent was allowed to which a certain amount of scientific, if not commercial, interest may be attached. It is proposed to attempt the extraction of gold from extremely dilute solutions, such as sea water, by means of treatment with colloidal carbon. Assuming that the action is one of adsorption, and that there would be a selective preference for the gold compound rather than for the other salts in solution, the idea might have a wider application.

Investigation into the question of the effect of the interaction of aurocyanide solution and colloidal carbon was proposed some years ago, but nothing further was heard of the subject until it was suggested that the excellent results being obtained in the new Moore-Edmands process[*] were partly due to the fact that some of the ground charcoal used was in the colloidal condition. This would suggest colloidity by subdivision, and is no adequate explanation of the fact that precipitating power regularly increases as reduction in the particle size of the precipitant increases, although it is feasible to infer that colloidal carbon may be released by comminution.

Aluminium and Zinc Precipitation.—The high price of aluminium has resulted in decreased attention being paid to the substitution of this metal for zinc as a precipitant. In one case, however, the change has been reported to have been followed by a marked saving in cyanide and lime. The only trouble experienced was due to an accumulation of calcium aluminate in the piping; and improvements are being made to prevent or decrease this. A further reduction in the amount of dust used is anticipated. Aluminium is also being used in place of zinc at the plant of the Cia Beneficiadora de Pachuca, Mexico, and considerable economies are being effected.

Apart from the introduction of de-aërating apparatus at several plants, no change is to be noted in zinc-dust practice, although attention has been drawn to alternative methods of estimation of the purity of the product usually used.

A modification of normal practice is to be noted at the McIntyre Porcupine plant, where it has been decided to instal the Miller chlorine process in order to produce a high-grade product, and so avoid the excessive marketing expenses associated with a comparatively low-grade bullion.

Zinc-shaving precipitating practice has progressed little, but is still widely adopted. Attention has been paid to the various refinements of operation which have been introduced during several years of progress; but it is to be regretted that prominence is still given to types of apparatus which have aided in bringing the process into disrepute. The practice of adding lump cyanide at the head of the box, in an effort to counteract the inertness of the solution met with in many close-circuit plants, is being more extensively discouraged, and, as a result, economies of both cyanide and zinc are usually achieved.

Sodium Sulphide in Cyaniding.—An interesting development in the metallurgy of gold has taken place in connection with the cyaniding of the quartz ore at Prestea mine, Gold Coast Colony, West Africa. The deposit is crossed with seams of carbonaceous schist, which is also found in close proximity to the vein; and, during cyaniding operations, some of the gold is prematurely precipitated on the graphite. This resulted in high residues; but subsequent experimentation indicated the feasibility of using sodium sulphide as a corrective in a later stage of treatment.

As practiced at the Prestea, the new modification consists of drainage, after cyanide treatment in leaching vats, and re-treatment with 0·2% sodium sulphide solution. The material is then water washed, and the residue discharged. The gold-sodium sulphide solution is passed through copper shavings, where the precious metal is deposited, and receptacles similar to ordinary zinc boxes are used. The gold precipitate is filter-pressed, dried and smelted. Copper-gold bullion, matte, and slag result, which assay 100 fine, 33 oz. per ton, and 12 oz. per ton, respectively. The new process recovers an additional 50 cents' worth of gold per ton of sand treated.

With regard to the theory of this interesting development, it has been proposed that the sulphide was a solvent for the gold precipitated on the carbon. More recently a hypothesis has been advanced which draws attention to the evidence in favour of the theory that a gold solution is adsorbed by the carbon rather than chemically acted upon by occluded gas, and that the addition of sulphide introduces new factors of surface-tension influence, with the result that a part of the adsorbed gold compound is released and is available for treatment with a precipitant.

A comparatively recent modification in connection with the precipitating of gold and silver received publicity in 1918. A brief account of T. B. Crowe's experiments and the practical results achieved by de-oxidizing cyanide solutions by means of a vacuum, prior to zinc-dust precipitation, was published, but few details were given. The new system was used throughout 1917, and results for six months' operations were given in the paper which was read at the September, 1918, meeting of the Institute at Colorado.[*] It is to be noted that considerable savings have been effected in the consumption of zinc dust and cyanide.

Mr. Crowe's explanation of the theory of the reactions involved assumes that nascent hydrogen is the active precipitating agent, and that its combination with oxygen in the solution reduces the precipitating efficiency. This view is opposed by O. P. Watts, who draws attention to the fact that the dissolving of zinc in a solution of pure sodium cyanide is an example of the displacement of one element by another; and that, when zinc is immersed in a dilute cyanide solution containing gold, two reactions occur simultaneously—some of the zinc is dissolved by the double cyanide of gold with precipitation of the precious metal, and a portion of the zinc dissolves in the sodium cyanide, forming hydrogen.

The distinctive feature of the new modification is undoubtedly the saving of zinc and cyanide resulting from the feasibility of abolishing the practice of adding lump cyanide at the head of the presses. In this connection it is interesting to note that the Crowe modification is a radical departure from the practice, so often found beneficial in improving precipitating efficiency with zinc-shaving precipitation, of *oxidizing* the solution, before it reached the boxes, by treatment with air. The purpose was doubtless to accelerate action by insuring the prompt removal of occluded hydrogen from the surface of the zinc shavings, and so exposing fresh areas of the precipitant. Such a method would be unlikely to insure any economy in the consumption of either zinc or cyanide, although improved precipitation results were often obvious.

The theory that the presence of oxygen assists in depolarization is questioned by H. A. White,[†] who has contributed a new method for the estimation of this element in cyanide solution. Typical analyses of solution in a Rand zinc box showed that there was little precipitation of gold in the first compartment, although the percentage of oxygen in the solution was high. In this instance, however, other factors are to be taken into consideration. The first compartment of the box may contain the bulk of the white precipitate common in that district, so that vigorous action would be unlikely in any case. The white precipitate is found when free cyanide content is low, and it would be interesting to know whether its formation could be prevented by means of a preliminary de-oxidizing of the solution.

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[*] See this Journal, Vol. 19, July, 1918, pp. 7-13.

[*] See this Journal, Vol. 19, Nov., 1918, pp. [illegible].

[†] See this Journal, Vol. 18, June, 1918, pp. 292-297.

The whole subject of the reactions involved during the precipitation of gold in aurocyanide solution by zinc shavings or dust constitutes a field for investigation, particularly in relation to the interfering or helpful influence of oxygen. Comparative figures will doubtless be available at a later date, and a more complete hypothesis may be suggested to account for the results.

Apart from theories as to the cause of the abstraction of gold from aurocyanide solution by charcoal, and the proposals as to the actual reactions occurring during precipitation, little advance in the chemistry of the process can be recorded. White's method for the estimation of oxygen provides an apparently reliable system of testing, which it is hoped will lead to the publication of data of interest.

Gravity Leaching Practice with Gold Ores.—There is no question as to the comparative cheapness per ton capacity of a large leaching plant, as compared with the equipment necessary for any other wet chemical method. The resulting low cost of operation would be an added incentive to the inclusion of a large tonnage of gold-ore reserves, now considered as unprofitable because of the expense of reduction to slime, the difficulty of entirely isolating, for precipitating purposes, dissolved gold associated with slime, and the high cost per ton when operations are carried out on a small basis.

It is interesting to note that during 1918 experienced expressions of opinion in favour of leaching treatment for gold ores have been in evidence. A few yeras ago the logic of such views would have been questioned. It would have been recalled that leaching was the first system adopted on a working scale to recover gold from cyanide solutions, and that new methods should receive greater attention. Such a line of argument was favourably received by many engineers. In spite of this, however, it is interesting to note that the bulk of the gold recovered by the cyanide process is still obtained by leaching. In view of its general applicability to all classes of simple gold ores, I predict that it will survive so long as cyaniding is in practice.

Attention has been drawn to the neglect to realize that the economic leaching of gold ores involves comminution according to requirements. Certain ores will leach satisfactorily when crushed to ¼ in., or even larger, but, where the gangue is hard and the gold finely disseminated, fine crushing is imperative. The scope of leaching is little understood. A very fine sand, passing an 80-mesh screen, will often leach satisfactorily, and can be treated with only a fraction of the expense involved if sliming is practiced. It is certainly too common for metallurgists to attempt experimental leaching on, say, 20-mesh material; and then, because the results are unsatisfactory, as they almost invariably will be, go to the other extreme and finally affirm that sliming to 200-mesh is the only solution of the difficulty. Had this last-mentioned policy been adopted more extensively, it is probable that many, instead of comparatively few, gold properties would have failed to pass the recent crisis without suspension of operations, and would have been obliged to close down, at least temporarily, on account of the high cost of treatment. As matters stand it is probable that greater attention will be paid to the refinements of leaching practice as applied to the metallurgy of gold, in the near future, in an effort to solve the problem of the treatment of low-grade deposits, even as the copper metallurgists have done, although, of course, on a smaller scale.

The features of successful practice needing emphasis are (1) the feasibility, in many instances, of treating by gravity leaching a large proportion if not all the slime produced; (2) upward percolation; (3) counter-current enrichment of solution and the avoidance of unnecessary precipitation; (4) degree of grinding and depth of charge to insure (a) avoidance of slime being washed through the crevices between adjacent coarse particles, (b) normal percolation rate, and (c) satisfactory extraction of the metal; and (5) the ability to distribute homogeneously a leaching charge after dry crushing or dry crushing and roasting. The practicability of the amalgamation of leaching plant residues has received little or no attention."—A. W. Allen.—*Engineering and Mining Journal*, Jan. 11, 1919, p. 92. (H. A. W.)

MINING.

Rock Bursts in Mysore Mines.—"In the March *Bulletin* of the American Institute of Mining Engineers, E. S. Moore wrote on rock-bursts and air-blasts in the Indian gold mines.* This paper brought a contribution to the discussion from Dr. W. F. Smeeth, Chief Inspector of Mines for Mysore, who has already written on the subject, notably in a bulletin published by the Mysore Geological Survey in 1904. As this subject is once more attracting attention, we quote liberally from Dr. Smeeth's latest contribution.

The term 'air-blast' was many years ago in use in the Cornish mines where rock was encountered which showed a tendency to fly, or split off violently in small fragments; this was referred to by the miners as 'airing.' Some 15 or 20 years ago similar phenomena became prevalent in the Kolar goldfield and were referred to in the same terms. But about the same time more than usually violent effects, which involved the displacement of considerable masses of rock, the smashing of large timbers, and production of violent shocks, which were distinctly and alarmingly felt at surface, began to attract attention. A study of a number of cases led Dr. Smeeth to divide these phenomena into two classes, one of which is called 'quakes' and for the other he retained the term 'air-blast,' then in common use. The distinction which he endeavoured to make was that quakes were larger and more serious phenomena, involving considerable destructive effects underground, accompanied by perceptible shocks at surface, and due, essentially, to the sudden fracture of pillars or blocks of quartz left standing in the workings during the course of mining operations. The failure of such pillars was considered to be the result of compressive or shearing stresses due to superincumbent weight, which was a function partly of the depth from surface and partly of the extent to which the surrounding quartz ore had been stoped, thereby increasing the weight to be supported by the pillar. The suddenness and violence of shock depends on the physical characters of the ore and of the overlying and underlying rock (hard crystalline hornblende schist and epidiorite) which do not permit of quiet deformation, or adjustment, with the result that disruption is correspondingly violent when the breaking stress is reached. Air-blasts, on the other hand, were restricted to bursts of rock, whether of quartz, hornblende schist, or trap dike, which occurred in circumstances which seemed to preclude superincumbent pressure as an essential factor, and were considered to be due to intrinsic strain in the particular mass of rock involved. If a pillar of quartz is under great stress due to superincumbent weight, and if, in addition, some of the adjacent rock is in a condition of intrinsic strain due to other causes, there may obviously be any combination of a quake and a rock-burst ; the one may set the other off and the resulting effects may be greater than would have been the case with either acting alone. But, in Dr. Smeeth's opinion, the quake may, and often does, take place without any of the rock concerned being in a condition of what may be called intrinsic strain, and therefore, without the production of an air-blast or rock-burst. In the Rand mines, rock-bursts in shafts, drives, or cross-cuts, far removed from stoped areas, are practically unknown, and the strained rocks, such as those at Kolar, do not appear to exist. This is evidence that violent quakes may occur as the result of pressure due to weight alone, quite independently of strain due to other causes, and the evidence is clearer than that obtainable at Kolar where both sets of conditions are frequently associated.

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*See this Journal, Vol. 19, Nov., 1918, pp. 81-3.

When Dr. Smeeth started his investigations, 17 or 18 years ago, rock-bursts were not very serious features and little was done to guard against them. Quakes were comparatively rare and were regarded as bigger air-blasts or as falls of ground. Comparatively little timber was put in, except in shafts and to support heavy ground, and systematic filling of stopes was practically unknown. The shafts were nearly all inclined and carried down along the course of the quartz veins or shoots, and pillars of quartz or poor rock were numerous throughout the stopes. The recognition that pillars were a source of danger, which was bound to increase with the extension of stoping and with increase of depth, led to a general change of policy. Inclined shafts have, in recent years, been carried in the solid hanging or foot-wall rock. In the case of several of the old shafts, which have been smashed up, time after time, owing to the failure of some of the supporting pillars, the bold step was taken of entirely removing these pillars and replacing them by timber and packs of waste rock, with the result that most of the trouble has ceased.

Stoping is planned, as far as possible, to avoid the leaving of small pillars by taking out the ore in large blocks as rapidly as possible and leaving large blocks of untouched ground between them. In the leaving of these large blocks advantage is taken of poor zones between the payable shoots, but where these are not available large blocks of payable ore may be left for future exploitation.

Systematic filling with waste rock, some of which is sent down from surface, has been extensively developed and, in the steeper mines, methods have been devised for securing considerable consolidation of the packing. At first, it was customary to carry a stope down for a depth of 30 ft. and then put in a stull and fill the excavation with waste rock. Another 30 ft. was then stoped below the first stull, and a second stull, with packing on top, was put in. The final 30 ft. was then taken out and similarly packed. The result of this method was that the three separate sets of packing were poorly consolidated and afforded little support for the hanging until the latter had closed down considerably and caused dangerous strain in adjacent pillars or in the more massive bands of rock in the hanging itself. These strains were relieved by sudden fractures accompanied by severe shocks, the smashing of heavy timbers, and the filling up of levels and stopes with broken timber and rock. In other words, although this filling was doubtless of some service, and was preferable to the practical absence of filling previously in vogue, it failed to prevent a marked increase in the number and intensity of the quakes with increase of depth and extension of stoped areas.

In this connection it may be as well to note that failure of pillars under excessive weight is not the only source of quakes, and it is remarkable that quakes have been much less frequent in the Mysore mine, where the stopes dip at 45° to 50°, than in the Champion Reef and Ooregum mines where the dip is from 60° to 80°. In the latter mines the stress on pillars, due to weight, will be very oblique to the axis of the pillars, and failure will be due, largely, to shearing forces. Where the dip is very steep, much of the weight will go to produce a longitudinal thrust, in the direction of the dip, on the beds or bands of rock in the hanging, and as these vary in texture and schistosity we may expect that some of the more massive bands will take upon themselves the greater part of the burden ; and if allowed to bend, to any great extent, they are liable to snap suddenly, with the result that a disastrous quake is produced. The importance of supporting the hanging as early as possible is obvious, and the following method has been adopted, for some years, with a view to getting in the filling before any wide extent of hanging is exposed, and of obtaining as much consolidation as possible.

A heavy packed stull is put in at the back of the lower level. From the level above, a stope, 30 ft. in length, is carried down to the bottom stull as rapidly as possible, and stulls, covered with 4 in. × 4 in. lagging, are put in at depths of 30 ft. and 60 ft. to protect the workers from loose fragments or rock-bursts during this operation. The ends are also boxed in. When the stope is finished, the laggings are removed, and sometimes also the intermediate stull pieces, and waste rock is shot down the whole depth of the stope from the level above. The next stope is similarly treated, and so on until the entire block had been removed. The method has proved satisfactory in operation and there is little doubt that it has saved many quakes, though it has by no means entirely obviated them. It is impossible to get any filling which will take up its work at once without material shrinkage, whether the filling be waste rock or the water-borne sand which is now so largely used in the Transvaal. The hanging will therefore settle down to an appreciable extent, and in the case of hard rocks with low elastic limits the pressure will be unequally and dangerously distributed on certain pillars, or the more solid bands in the hanging will reach their limits of tensile or shearing stress and yield with sudden violence.

Other methods of stoping and filling are at present under trial.

As the rock-bursts have been known to occur at all depths from about 600 ft. below surface downward, it is obvious that the mere weight of the overlying rock can contribute little, if anything, to the causes that produce them. They occur most frequently in the quartz of the veins—probably due to the fact that a greater footage is driven in quartz than in other rock—but they are not of any considerable magnitude or violence in this material. Occasionally they have been known to occur in the trap (dolerite) dikes which cut across the formation from east to west or north to south, and they occur fairly frequently in the more massive hornblende schists and epidiorites which form the mass of the country. Sometimes they occur at or close to the working end while excavation is in progress; more frequently, some little time after the excavation has been made, as though the internal strain took some time to reach a critical point, and occasionally the effect is delayed until several years after the excavation, such as a shaft, has been completed and used. The bursts are quite sporadic. A working may be driven for many feet, and even for thousands of feet, with no sign of trouble when, without warning, a burst or a series of bursts may occur, or a zone or patch of rock may start firing itself off for some considerable time, and the working may have to be suspended until the display is finished.

It does not seem possible to suggest any means of preventing the occurrence of rock-bursts, but a great deal has been done to protect workmen against the more numerous bursts which are not of exceptional violence. In vertical shafts a movable protective shield is provided below the point to which the brick lining has been put in. In underlie shafts and in many winzes, drives, and cross-cuts, either permanent or temporary timbering is carried as close to the working faces as possible. When a patch of ground which shows a tendency to burst is being driven through, work is frequently suspended to give the strains a chance to relieve themselves. Some bursts are so unexepected or so violent that no amount of care or protection is of any use and regrettably large loss of life, or injury, occasionally occurs. For some years past a well-equipped seismological observatory has been installed on the field by the mining companies under the management of John Taylor & Sons. This is in charge of H. M. A. Cooke, superintendent of the Ooregum.

In concluding, Dr. Smeeth is not prepared to admit that these rocks are, on the whole, under great compression at the present time. No doubt they were highly compressed when the schists were folded, as well as after the introduction of the quartz veins which are crushed, faulted and intersected by great faults with slickensided walls. Much of the pressure and movement probably accompanied the intrusion of the Peninsular gneiss in Archæn times, and since Archæn times there is no evidence of pressure or differential movement in the rocks of the State. In Pre-Cambrian times the rocks, both schist and gneiss, were penetrated by a great series of dolerite dikes which traverse them in east and west and north and south directions. The walls of the dikes show no signs of faulting, brecciation, or slickensides, and the dikes show no signs of pressure, faulting, or folding. It seems probable that the dikes welled quietly into a great rectangular series of contraction rifts due partly to contraction, resulting from the cooling of the great mass of the Peninsular gneiss, and to buoyancy which accompanied extensive denudation. Since that time, denudation has continued uninterruptedly, and many thousands of feet of schist and gneiss must have been removed with consequent relief of compression, which would be further relieved by secular cooling and shrinkage as the depth from surface was reduced. In the absence of any evidence of existing regional compression, it seems reasonable to conclude that the original compression which produced folding, faulting, slickensides, etc., has been largely, though unevenly, relieved. If some portions of rock still remain in a state of squeeze it is open to doubt if they would burst out in large pieces, though some shaling might occur, as in the case of pillars under great weight. If there are residual strains remaining from the period of great compression and folding it is probable that the more important of these are connected with the bending of the more massive layers and local inequalities of adjustment. Parts of the rock will be in tension and parts in compression, and the former will be those to give way first and most frequently. They may also be bending moments due to the regional elevation of the Mysore Plateau, though there is no evidence of this at the present time, or there may be a certain amount of stretching due to buoyancy resulting from the removal of a great superincumbent layer. If we add the shrinkage due first to the cooling of large igneous masses of gneiss and later to reduction of temperature from degradation of the surface, there appears to be ample opportunity for the production of tensional strain, which will be locally and variably distributed according to the varying character of the rock layers and local adjustments previously effected. Such earlier adjustments are suggested by the cross joints filled with calcite and quartz, and present-day adjustments, apart from the rock-bursts themselves, are suggested by the frequent tendency of the foot-wall to loosen itself in large rectangular blocks and the occasional occurrence of fissures in both the foot and hanging walls which show no tendency to close. It may be that the excavation of the mine workings, followed by lowering of temperature due to ventilation or compressed air, is often the last straw which carries the tensile strain past the critical moment. These rock-bursts occur in the trap dikes and there is no suggestion or evidence that the dikes have been subject to compression since their solidification. On the other hand, we cannot doubt that they have cooled and contracted, and as they are firmly frozen to the enclosing rock it is probable that they are under tension, with a tendency to shrink and rupture when the enclosing envelope is pierced. Dr. Smeeth does not suggest that the tendency of the dikes to contract produces a condition of tension in the schists, but the fact that rock-bursts occur in them suggests that the similar phenomena in the crystalline schists may likewise be due to tensional stresses in spite of the fact that schists were, obviously, at one time under great compression. The compression of the schists as a whole does not preclude a state of tension in some members, and there are grounds also for believing that active compression has long ceased, and the rocks have since been subject to contraction and stretching."—W. F. Smeeth.—*Mining Magazine*, original source contribution to discussion, March *Bulletin*, A.I.M.E., March, 1918. (J. C.)

MISCELLANEOUS.

Modern Training of the Chemical Engineer.*—"At a meeting held at the College of the City of New York under the auspices of the College Chemical Society, April 25, Dr. Ralph H. McKee, professor of chemical engineering of Columbia University, presented a paper dealing with certain phases of chemical engineering education, particularly with recent changes in the curriculum.

We may define the scope of a chemical engineer's work by saying that he applies knowledge obtained from the field of pure science and from the field of engineering to the solution of the problems of applied chemistry. Due consideration must be given to the financial element, so that the solution may be commercially practicable.

A process must go through several stages before it becomes a part of chemical industry. After leaving the laboratory, the process is developed in a small-scale plant. If successful, a full-sized plant is next constructed and operated by partially skilled labour, after having been trained by the technical staff. Following the initial operating period, refinements in the process are made by the chemical engineer.

Some fifteen years ago, when chemical engineering was in its infancy, there was considerable discussion as to whether the training of a chemical engineer should be primarily along engineering lines and only secondarily chemical, or *vice versa*. A number of the larger universities took the former attitude, but at the present time it is conceded that the emphasis should be placed upon the chemical training. It is essential that the instructors should be familiar with actual practice and should not have to rely on text-books. It has been said that text-books of industrial chemistry are mostly descriptions of methods that are obsolete. This statement was made twenty years ago, but it is even more true to-day. The Chemical Warfare Service took on an average three months to develop a new process and by that time the process was often obsolete. Of course, this work was done under the stress of war-time necessity, but it is, nevertheless, an indication of the changes which are constantly taking place in the industry.

In industries of a mechanical nature, production costs may be distributed approximately as follows: Labour, 35%; materials, 35%; overhead, 30%; while for a chemical plant the cost of labour may vary from 12% to as low 1%; materials, up to 90%: overhead, in some cases 30% to 35%. It is evident that in the chemical industries, efficiency of operation and maximum output are the main factors governing cost of production. A 3% increase in yield may be equivalent to cutting the labour cost in two.

While the cost of labour is not a major item, labour itself is exceedingly important. The technical force should be well paid and the labourers should be fairly intelligent, as carelessness on their part may result in large losses of valuable materials. Carefulness and willingness of workmen to follow instructions are more important than education. It is interesting to note the possibilities which may result from the employment of psychological tests, such as have been used in the United States Army, in the selection of labour.

Twenty years ago, the chemical engineer studied general chemistry, qualitative and quantitative analysis (including assaying) and text-book work only in metallurgy, organic and industrial chemistry. Ten years ago, physical and electro-chemistry were added to the list, emphasis being placed upon the theoretical treatment of three subjects. At the present time the tendency is to increase the time devoted to laboratory work in the general, organic, physical, electrochemical and industrial chemistry courses, and to cut down the work in qualitative and quantitative analysis, metallurgy and the class-room work in physical chemistry. Assaying is generally omitted. During this same period, in connection with the other college courses, there has been a decrease in the amount of drawing and mechanical engineering required, and civil engineering has been largely eliminated. In their place we find heavier courses in physics, a study of business law, contracts, specifications, etc., and certain phases of biology, such as the utilization of bacteria, yeasts and moulds which are capable of producing chemical transformations.

Since there are different requirements for chemical engineers, there should be different kinds of chemical engineers. With this object in view, the present graduate courses in chemical engineering at Columbia University have been chosen primarily for the purpose of training men who may become superintendents and managers of plants, and less for work in industrial research laboratories. The phases of the work given at Columbia but not customarily given in undergraduate curricula of chemical engineering are the following:

1. Chemical factory machinery, including plant construction and apparatus layout.
2. Applied colloid chemistry.
3. Factory wastes disposal.
4. Plant management, including problems relating to labour, insurance, laws governing dangers, compensation, etc.
5. Efficiency engineering.
6. Laboratory courses using standard semi-factory size equipment.
7. One summer vacation period of eight weeks must be spent by the student in a factory as a labourer in order that he may be able to understand the workman's point of view.
8. In the third year, the student takes up a research problem of a factory type.

So far as I know no university teaches its engineering students the handling of labour and employment. The indications are that these subjects may be satisfactorily taught in the class-room. We at Columbia are trying to work out a method of handling these subjects but we have not yet quite reached the stage where we are ready to offer such courses to our chemical engineering students. Army experience has shown the value of psychological tests, and experiments in scientific labour employment in several factories have proved successful. In one plant employing 6.000 persons, it was found necessary to hire 15.000 in 1917, so that the labour turn-over was 2½. After the introduction of psychological tests, a report showed that the excess labour amounted to only 3.000 per annum, or a labour turnover of 1½. Since it costs from $75 to $300 to break in a new man, depending upon the nature of the work, the importance of reducing labour turnover to a minimum is apparent."—Dr. R. H. McKee. — *Chemical and Metallurgical Engineering*, May 15, 1919, p. 503. (W. A. C.)

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*See this Journal, pp. 151 and 191, March, 1919.

Abstracts of Patent Applications.

369 17. Merrill Metallurgical Co. Improvements in the precipitation of metals or materials from solutions. 23.6.17.

The above application claims generally chemical or mechanical means for removing oxygen or other gases from gold-bearing cyanide solution prior to or during precipitation of the gold contents.

312.18. E. C. Harsant. A machine for a continuous process for impregnating a solid with a vapour or gas. 10.6.18.

This application relates to a machine for continuously impregnating powdered solids with gas, and consists of a cylinder fitted with interior vanes which lift the powder passing through. The impregnating gas is passed through from the discharge end.

351.18. Chas. Spearman. Process for separation and concentration of minerals from their ores. 1.7.18.

This application is for a flotation concentration process patent. The process specified and claimed is an adaptation of the principles of selective filming by oil and agglomeration of the mineral so wetted. Flotation is effected not by the usual frothing method, but by floating the oiled mineral agglomerations on a body of liquid having sufficient surface film tension to prevent rupture.

391.18. I. B. Olsson. Improvements in rollers for supporting winding and hauling ropes and the like. 10.7.18.

The applicant proposes to use the drum or barrel of the roller as a reservoir for lubricants, loose ends secured in position by long bolts grip the ends of the barrel and may be fitted with ball or roller bearings, the spindle is fixed in the pedestals carrying the roller and a spring cap is provided at the ends to keep a suitable washer in contact with the pedestal bearings, to prevent the escape of the lubricant employed.

453.18. Ralph Hush. Improvements in mills or machines for grinding or pulverizing ore and other materials. 7.8.18.

This application refers to improvements with regard to disc grinders and pertain. Firstly, to the construction and arrangement of the door also to the means whereby the stationary grinding element is secured to the said door. Secondly, to the construction and arrangement of an adjustable bearing for the spindle which drives the rotating disc. Thirdly, to the construction and arrangement of the locking means for regulating or adjusting screw for the driving spindle. Fourthly, to the construction of the disc.

491.18. Lionel Isaac Harris. Improvements in purifying air in mine working places. 15.8.18.

This application refers to the placing of one door or a series of doors in a development drive in order to keep the dust caused by blasting, shoveling, etc., from going into the mine workings. The door or doors are provided with a dust collector as described in Patent Application No. 290.19, in the name of the above applicant.

490.18. Lionel Isaac Harris. Improvements in collecting dust from air. 15.8.18.

This application refers to an apparatus for the collection of dust samples and also an apparatus for collecting dust and thus purifying the air. In the second part of the application this is achieved by having small jets of air impinging upon wet plates.

510.18 and 105.19. W. H. Gordon. Improvements relating to stamp heads of stamper bars. 26.5.19.

The application refers to an arrangement of compensating weights to be fitted on battery stems. The weight is made with an opening on one side to allow of its being placed on the stem without having to be passed over the end, and this opening is filled up by a wedge piece engaging in grooves in the sides of the opening; a taper bushing—in halves—is provided to be driven down into the central hole of the weight and a ring of fibre or other suitable material interposed between the bushing and the stem, to give a more or less adaptable grip when the bushing is driven home.

555.18. William Smith. A safety device for preventing explosions in air compressors, delivery pipes, and adjacent receivers. 9.9.18.

Claim one reads as follows: "In combination with an air compressor, a thermally responsible device in contact with compressed air liable to overheating and mechanism controlled by said thermally responsive device for preventing further compression of such air." Other claims are for the apparatus in connection with the main claim.

746.18. Gustav Haglund. Improvements in or relating to the separation and refining of metals. 12.12.18.

This application is for a process of separating alloys of copper and another metal (*e.g.*, nickel) by granulation, and treating the granules with an acid solution such as sulphuric acid; dissolving both metals to neutralization of the solution. The treatment of the granules is continued with the neutral solution whereby copper is cemented out leaving nickel only in solution. The nickel is recovered electrolytically.

Changes of Address.

Aspland, C. H., *l/o* Simmer Deep; Rouxville Diamonds, Ltd., P.O. Aliwal North, C.P.

Ball, H. Standish, O.B.E. (late Major, R.E.), from Active Service; care of Standard Bank of S.A., Johannesburg.

Degenhardt, W. R., *l/o* London; c/o Burma Mines, Ltd., Namtu, Northern Shan States, Burma, India

Gow, G. A., *l/o* Wellington, New Zealand; Lebong Tandai, Res. Benkoelen, Sumatra, D.E. Indies.

Pam, E., O.B.E. (late Lt. Col.), *from* Active Service; Geldenhuis Deep, P.O. Box 54, Cleveland.

Pryce, L., *l/o* City Deep; Rand Mines, Ltd., P.O. Box 4563, Johannesburg.

Richardson, A., *l/o* Dept. of Scientific and Industrial Research, Westminster; The Royal School of Mines, South Kensington, London, S.W.7.

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Vol. XX OCTOBER 1919. No. 4.

Proceedings
AT
Ordinary General Meeting, September 20, 1919.

The Ordinary General Meeting of the Society was held in the South African School of Mines and Technology Building, Johannesburg, on Saturday, 18th October, 1919, Mr. Jas. Gray (President) in the chair. There were also present:—

16 Members: Messrs. J. Chilton, G. A. Watermeyer, C. J. Gray, J. H. Johnson, A. King, J. J. R. Smythe, H. A. White, J. R. Thurlow, A. McA. Johnston, W. R. Dowling, Prof. J. A. Wilkinson (Members of Council), C. A. Meiklejohn, J. D. O'Hara, Lt.-Col. E. Pam, O.B.E., H. A. Read, H. R. S. Wilkes.

2 Associates: Messrs. J. Gibson and J. A. Woodburn.

4 Visitors, and Fred Rowland (Secretary).

MINUTES.

The Minutes of the Ordinary General Meeting, held on 20th September, 1919, as recorded in the September *Journal*, were confirmed.

NEW MEMBER.

The Secretary: The Council has admitted the following Student member:—

Watts: John Higington, Aurora West United G.M. Co., Ltd., P.O. Box 26, Maraisburg. Reduction Works Learner.

General Business.

FOURTH MINING EXHIBITION.

The President: I would like to draw your attention to the fact that the Fourth Mining Exhibition will be held from Wednesday, the 21st January, to Saturday, the 31st, both days inclusive.

It will be remembered that it was originally arranged to hold the Exhibition from the 5th to the 12th November, but unfortunately we were unable to get the Assembly Hall of the School of Mines on those dates, consequently we have been compelled to postpone it until January. I think, owing to the longer time available, we should make a greater success of it. The entries close on the 31st December.

WELCOME TO LT.-COL. PAM.

The President: You have probably not observed that Lt.-Col. Pam, O.B.E., has just arrived, his first attendance since his return from active service a few weeks ago, after some years at the front. By your enthusiasm you have given him the proper greeting.

PROPOSED WAR MEMORIAL TO FALLEN MEMBERS.

The President: I desire to bring to your notice to-night the question of a Memorial to those members and associates of the Society who have fallen in the Great War. These comrades of ours, to the number of 18, as far as is at present known, have played a great and honoured part, and I feel that it is but fitting that we should perpetuate their memory by some form of memorial.

As you know, a tablet inscribed with the names of those of our members and associates who died in the Boer War is at present housed in the Chamber of Mines Building, and recalls most vividly to those who observe it the memory of those gallant fellows.

If my suggestion meets with approval, I think that a sub-committee should be elected this evening to consider the matter in all its aspects. The living can do little for the dead. The voice of praise cannot please the closed ear nor the fury of reproof torture it, but we, in the crowd, can render a tribute of gratitude and respect to those whose dauntless courage has secured for us the great deliverance.

Lt.-Col. E. Pam *(Member):* I did not come here intending to speak to-night, but having just come from England I would like to call your attention to the War Memorial which was built—designed, I think, by Sir E. Lutyens in Whitehall. It consists of a very simple cenotaph and the only inscription is "To Our Glorious Dead."

One of the most extraordinary sights in London to-day is the constant crowd laying flowers at the base of this memorial. It appeals to all classes, and one can see a fashionably dressed woman add a magnificent wreath to the mass of flowers and a minute after a poor woman place a simple posy of wild flowers next to it.

I do not suppose that the Chemical, Metallurgical and Mining Society could build such a memorial alone, but combined with other bodies some such scheme would be possible. I would suggest for discussion by the committee that the bulk of the money collected be used to assist a general memorial of this type and that, in addition, a simple plate with names be erected in a suitable spot.

Prof. J. A. Wilkinson *(Past-President):* I have much pleasure in seconding the proposal of the President that a sub-committee be formed of the members to discuss this matter in all its bearings and to bring forward concrete suggestions for your acceptance. I should like also to suggest that in a prominent place in the *Journal* the names of those members who have been on service should be recorded and, as far as it is possible to do so, their services. I think it is the least we can do; afterwards some more permanent form of memorial could be discussed.

The President: I consider Prof. Wilkinson's suggestion is most excellent; in fact, we might set apart a page in the *Journal* and publish a list of all the members who went on active service, in the form of a Roll of Honour, and give special prominence to those who have died on active service.

If there is no further discussion, I propose that we proceed with the election of a sub-committee, and I would suggest that the sub-committee should not consist entirely of Council Members; I think that members who are not on the Council should play a prominent part in this matter. First of all, the size of the sub-committee should be settled, and I would like proposals.

Prof. J. A. Wilkinson *(Past-President):* Six. This was agreed to.

The President: I now call for nominations.

The following gentlemen were then nominated and agreed to serve as a sub-committee in connection with the proposed War Memorial to fallen members:—Lt.-Col. E. Pam, O.B.E., Messrs. A. MacArthur Johnston, W. R. Dowling, H. A. White, H. A. Reid, and Prof. J. A. Wilkinson, with the President *ex-officio*.

WELCOME TO MR. R. R. KAHAN.

The President: Before we proceed to the further business of the meeting, I would like to accord, in your name, a very hearty welcome to Mr. Kahan, who is with us this evening. He has come here from India and Australia, as you know, at the request of the Chamber of Mines in connection with the gold refinery. I hope his visit to South Africa will be as profitable to him as I am sure his visit will be to us.

Mr. R. R. Kahan *(Visitor):* I did not come prepared to say anything to-night; I thought I would listen to your discussions. However, as you have been kind enough to say a few words of welcome, I thank you very much for them and for the manner in which they have been received.

A GENERAL REVIEW OF THE ECONOMIC RESULTS ATTENDING THE GOLD AND BASE METAL MINING IN THE PRETORIA INSPECTORATE DURING THE PERIOD 1904 TO 1914.

By T. G. Trevor *(Member).* Inspector of Mines, Pretoria.

Mr. G. A. Watermeyer *(Vice-President):* As you know, Mr. Trevor has gone to Europe as a representative of the Government to further the interests of base metals in this country. Before leaving he gave us this paper, which he asked me to read for him.

I. Extent of Inspectorate.—The Pretoria Inspectorate of Mines consists of the following Magisterial districts:—Zoutpansberg, Pietersburg, Waterberg, Rustenburg, Pretoria, Middelburg, Carolina, Lydenburg, Barberton. It, therefore, includes the vast majority of the "outside" mines of the

Union. Coal and diamond mining are not included in this review, as the conditions governing them are different.

II. MINING VENTURES.—There are four stages in the history of a metal mine, viz:—

(a) The preliminary prospecting stage.
(b) The exploration prospecting stage.
(c) The development stage.
(d) The producing stage.

(a) *The Preliminary Prospecting Stage.*—In this stage a prospector or owner examines an area of country in search of indications worth exploitation. The Mines Department usually receives no notice of work at this stage, the actual cost of which seldom amounts to £50. It is probable, however, that, taking the Inspectorate as a whole, at least twenty-five farms or areas are examined for one that gets taken up for prospecting.

(b) *The Exploration Prospecting Stage.*—In those cases where something is found, the next step is usually to secure an option on the farm or to peg the claims, as the case may be, and to float a small syndicate to prospect the area. In this case there is generally an initial expense of at least £150 for option money, and up to £2,000 may be spent on the property before it is abandoned or the next step reached. The money for this object is usually found by some small syndicate either in the district town or in the Union.

In the years under review 464 of these ventures were reported to the Mines Department: of these 141 never got beyond this stage, but 323 carried on. These 141 prospecting ventures must have been closed down at a dead loss, which may be estimated on the average at least £500=£70,500.

(c) *The Development Stage.*—The local syndicate, having expended their capital and obtained what they consider good results usually attempt to float a company or to get a big mining house to take up the property. In the former case the capital may be local, and now frequently is, but in the latter case it is almost invariably from overseas.

Of the 323 properties which reached the development stage in the years under review, 122 got no further, but 201 succeeded in advancing to the next stage. The 122 mines which closed down during the development stage may be estimated to have closed at an average loss of about £2,500 each=£305,000 for the period.

(d) *The Producing Stage.*—When the owners believe that the property has been proved to have a reasonable chance of being payable, it is usual to float or refloat it into a definite mining company. The amount of capital of such a company may be anything, and sums up to £200,000 are not unusual. What proportion of this is working capital and actually goes into the mine or into plant, it is impossible to state. In considering the huge prices at which properties are put into companies it must be remembered, however, that these properties represent prizes in the lottery of prospecting and that, therefore, they must have a value commensurate with the risk and difficulty of obtaining them.

The money for this stage has almost invariably come from abroad, and even if in the first instance the company is financed in the Union, the greater portion of the scrip generally goes abroad and the equivalent cash is received in the Union. It must also be borne in mind that, though the capital of a company may be out of all proportion to the working capital, yet the money for the shares issued to water the capital ultimately comes from the investing shareholder, who is the mainstay of the mining industry. Though this ultimate shareholder has no say in the price at which he comes in, if he is unduly victimised, either by over-capitalisation, or by taxation for any considerable period of time, he will no longer invest; he is literally the "goose that lays the golden eggs," and starving or victimising him by any method will result in curtailing the supply of capital.

Of the 201 mines which reached the producing stage, 70 were still producing at the end of the period under review. Of these, however, only 30 survived till the 31st May, 1919. Of the 131 mines which started producing but closed down during the period, six were successful and repaid their workers, 11 may be classed as doubtful, the owners probably coming out about level, and 114 were distinct failures. Of the 70 which still continued producing at the end of the period, 40 have since closed down; of these 34 did not return their owners' capital and interest, two were probably successful and four doubtful. Of the 30 mines still running on the 31st May, 1919, 20 have probably been highly successful, having returned both capital and interest—in some cases many times over, eight can never be expected to repay their capital unless very unforeseen circumstances arise, while two are still doubtful.

It is practically impossible to give actual figures as to the capital involved in these 201 mines which started crushing, but the capital of the 14 largest concerns amounts to £3,215,000. The remaining 187 concerns were mostly smaller ventures, and if we average their capital at £10,000 each, it is thought that it would be a conservative estimate (£1,870,000).

It is, therefore, probable that the total amount of money directly invested at cost price (par) in metal mining during the period under review in this Inspectorate was not less than:—

(a) Preliminary Prospecting Stage	Unknown
(b) Exploration Prospecting Stage	£70,500
(c) Development Stage ...	£305,000
(d) Producing Stage ...	£5,085,000
	£5,460,500

To summarise, 464 mining ventures started, and of these 28, or, say, 6% have been definitely successful. The success of 17 is still doubtful, while 419 were definite failures. The 6% must, therefore, be regarded as prizes in a lottery in which the odds are 16·6 against the winner. To make the gamble an honest and attractive one the winner should, therefore, recover at least 16 times his stake, plus interest. It is certain that in very few cases has this happened. Probably the only case on record in the period under review where it has occurred is that of the Zaaiplaats Tin Mines.

It is, therefore, obvious that, from the point of view of cold reason, speculation in these mining ventures is not a profitable one, though it is certainly attractive, otherwise so much money would not be forthcoming for it. It remains to be shown in the forthcoming chapters whether or not it is profitable to the State.

III. *Production.* — The production of metals during the period under review was as follows:—

Gold	£7,740,438
Tin and Copper ...	£2,792,721
Total	£10,533,159

giving an average per year of £1,053,315.

What amount of the above is profit or loss it is impossible to state, but the following statement shows the amount spent in wages and the approximate amount for stores. The stores for the first six years are taken from the Government returns, but for the years 1911-1914 these returns are included with those of certain other districts. The approximation is, therefore, arrived at from the average of the first six years:—

Wages—	
White	£1,884,668
Coloured	£2,269,731
Stores	£3,820,585
Total	£7,974,984

Subtracting this sum from the total receipts for metals sold we get:—

Metals sold	£10,533,159
Wages and Stores ...	7,974,984
	£2,558,175

This sum of £2,558,175 has to cover all other expenses, including direct taxation.

IV. *Direct Taxation.* — Direct taxation takes two forms, viz:—

(a) Profits Tax.

(b) Mining Licences.

(a) During the period under review the paying mines declared £2,700,000 in profits, of which £500,000 was allowed for amortization, leaving a total taxable profit of £2,201,290, and of this the Government took £220,089 for the 10% Profit Tax.

(b) Mining licences, *i.e.*, claim, stand and mynpacht licences, amounted to £571,263. The total direct revenue derived by the Government was therefore:—

(a) Profit Tax	£220,089
(b) Mining Licences ...	£571,263
Total	£791,352

This is the last figure of cost at which we can arrive, and our balance sheet now stands as follows:—

Cr.	
Metals sold	£10,533,159
	£10,533,159
Dr.	
Wages and Stores ...	£7,974,984
Direct Taxation	791,352
Balance	1,766,823
	£10,533,159

The above balance has to account for all other expenses, save those mentioned, also interest and amortization for ten years on a capital which we have estimated at £5,460,500, which it is obvious it is insufficient to do.

Having taken the metal mines in the Inspectorate as a whole, it is now well to take some examples of individual mines of world-wide reputation and see how the economic factor works out. For this purpose we may take Zaaiplaats Tin Mine as an example of a bonanza, or highly payable mine, and the Transvaal Gold Mining Estates, Ltd., as an example of a permanently payable mine; the Sheba Gold Mine, the Messina Copper Mine, and the Barrett's Gold Mining Company as examples of mines which have not repaid the shareholders.

Zaaiplaats Tin Mine.—This mine was discovered by Messrs. Maggs and Munro in the year 1907. They started work with no definite capital; by August, 1908, they had produced ore to the value of £51,150, and it is probable that 60% of this, or, say, £30,000 was profit. In that year they floated the Zaaiplaats Tin Mining Company with a capital of £60,000, of which they received £50,000 in shares. These shares were almost immediately saleable at prices up to £20, so that the original proprietors each made a large fortune.

The company, in the years between 1909 and 1914, declared £318,000 in dividends, or 530% on its original capital, so that the shareholders who came in at par in those six years received 530% on their investment, while those who came in at the inflated price made 26½% during that period. In the meantime the company had exported tin ore to the value of £829,926. Adding this to the amount originally extracted by Messrs. Maggs and Munro we find that the State had been enriched by this mine between the years 1906 and 30th June, 1914, to the amount of £881,076; while the original proprietors made a fortune out of their ventures, and the original shareholders of the company made 530% on their investment. Unfortunately such mining ventures are extremely rare, and represent the first prize in the lottery of mining.

The Transvaal Gold Mining Estates, Ltd.—The mines worked by this Corporation were incorporated in the present company in May, 1895, though the name was changed to the present style in 1896. The capital is £640,000, of which £604,225 is fully paid up. There were also issued £124,000 worth of debenture shares in 1910. Up to May, 1914, the company had distributed £1,284,069 in dividends over a period of eighteen years.

The writer has no records showing the gold produced before the Boer War, but from September, 1902, to 30th June, 1914, the value of the gold produced was £3,412,303, plus £9,248 worth of silver, giving a total of £3,421,551.

Since 1914 the Company has been doing poorly, but, as its property consists largely of farms, the surface value of which is daily increasing, and the mines also still have untold possibilities, it is obvious that this concern has been highly profitable both to the State and to the original holders.

The Messina (Transvaal) Development Company, Ltd.—This Company was registered in January, 1905, with a capital of £250,000. It also has a debenture issue of £250,000. From the formation of the company in 1904 to the 31st December, 1918, it had produced copper to the value of £2,820,669 and declared dividends amounting to £109,073.

The cost of producing copper on this mine is not less than £100 a ton, and including railway guarantee and depreciation probably very much more than that sum.

It is, therefore, clear that the shareholders of this mine stand to lose very largely at the present price of copper, though the direct profit to the State has been enormous, more particularly as arrangements were come to in 1910 with the Government by which the Selati Railway was constructed through to Messina, some 250 miles. The company guaranteed to make good for ten years any loss in working, not to exceed 4½% on the £792,000, which was the estimated cost of the construction.

How the working of the Messina Mine has benefited the Northern Transvaal can hardly be described to anyone who has not seen it. From Duivels Kloof to Messina, a distance of about 100 miles, the whole country has become populated by thriving farmers; and the whole Limpopo Valley, which was formerly a wilderness, unoccupied either by blacks or whites, has now been taken up for ranching as a direct result of the operations of the mine.

It appears, from a statement made by the Manager of the Company, that about 54% of the total costs incurred by the Company are actually paid out at the mine.

The Sheba Gold Mining Company, Ltd.—This mine was originally discovered in 1885 by three partners, who pegged 25 claims. Nineteen of these claims were floated immediately in Barberton for £15,000. By September, 1887, this Company had paid 165% in dividends. It was then refloated in London for £600,000, the original Company getting 534,000 shares, which were at once saleable for £2. An original investor at par, therefore, won in under two years 165% in dividends and £71 for each sovereign invested.

The capital of the Company, which was originally £600,000, was increased at various times to £1,300,000 in February, 1904, and this may be taken as the amount of money actually put into the Company by the investing public, though most of it undoubtedly did not go into the mine. In 1911 the capital was reduced to £300,000.

From its inception in 1885 to the closing down in February, 1918, a period of 33 years, the mine crushed 1,659,549 tons of ore, and produced 952,715 ozs. of gold, valued at £4,046,876. Up to the closing down the dividends paid amounted to £888,831. Taking this as the total dividend in 33 years at a capital of £1,300,000, it is equal to 68% of the capital without amortization. Therefore, it may be said that the shareholders obtained 2% interest per annum for 33 years and lost their capital.

The Sheba Mine directly supported a white population of about 272 persons for over thirty years, and was also responsible for the opening up of the Barberton District and the permanent farming population which has settled there. It was also largely responsible for the initial success of the Rand Gold Fields, for legends of the wealth of this mine undoubtedly caused or encouraged the greater part of the early speculation on the discovery of the Rand, and overcame the bad impression which had been caused by the original failure of the Lydenburg Gold Fields.

The Barrett's Gold Mining Company.—This Company started in 1883 with a concession from the Government over the minerals on a farm of which it is the surface owner. It was reconstructed in 1887 and again in 1892 with a capital of £120,000 in ten shilling shares. It has worked continuously and has generally directly supported a local population of about twenty whites. It declared a dividend of 4d. a share in 1897, one of 8d. in 1898, and one of 5d. in 1899; beyond that it has never returned anything to the shareholders.

For the five years from 28th February, 1914, to the 28th February, 1919, the total costs on the mine were £71,325, and the value of the gold recovered was £71,392, giving a profit for this period of £67, out of which the head office expenses, etc., had to be met.

From this Company the Government draws a concession rate of £445 per annum, which has always been met. In this case the shareholders, who are entirely resident overseas, have lost both their capital and interest, with the exception of the insignificant dividends mentioned, but the South African Government has gained £445 per annum for 36 years, and approximately £15,000 worth of gold per annum has been put into circulation *de novo*.

VI.—The foregoing statements show that, taking the metal mining industry as a whole, it has been conducted at a dead loss to the speculators, but at a profit to the Government of £791,352 obtained by direct taxation, and a very much larger sum by indirect taxation, and at a profit to the State of £10,533,159, introduced *de novo* into the cash circulating in the country.

In contemplating the above, the writer, who has known the districts intimately for thirty years, was struck by the fact that though it has been demonstrated that the mining industry was carried on at a loss, yet it was obvious that the districts involved had profited immensely, and that wildernesses had been populated, railways built and permanent and prosperous farmers introduced by this non-paying industry. To account for this, although the writer had no prior knowledge of economics, he was compelled to indulge in the following elementary speculation, which he puts forward not as the last word on the subject, but states as a line of thought in the hope that it may be criticised by real students of economics, so that the truth may be arrived at.

When money merely changes hands between the citizens of a community or state, the wealth of that state is absolutely unaffected, but when property is created by the transfer, then the state is richer by that property which is the usufruct on the transaction.

Thus, if citizen " A " pays citizen " B " £100 for digging a useless hole in the ground, the State is no poorer but obtains no benefit from the transaction. But if, on the other hand, the money were paid for building a dam, the money would still be in the country and the State would be the richer by the permanent value of the dam.

If, however, "A" was a foreigner, then the State would in the first case be the richer by £100, and in the second by £100 plus the value of the dam. Where necessary commodities are produced the same thing holds good, but in the case of luxuries, middlemen's charges, legal expenses, etc., the matter is much more complicated and approximates to that of the useless hole in the ground.

In the case of a mine, if a capitalist works a mine, say, at a cost of £1,000 per month, which mine only produces £1,000 worth of gold (or other metal) per month, then that mine is run at a loss to the capitalist, who loses the interest on his money and the value of his personal attention.

On the other hand, the £1,000 which he spends still remains in the State, and a new sum of £1,000 has been extracted from the ground where it was valueless, and added to the wealth of the State; so that, although the capitalist has lost, the State has made £1,000 usufruct on the transaction in one month, which equals 100% per month.

It is true that in this work a certain amount of material, iron, tools, machinery, etc., which is imported, and which may be regarded as wealth, is destroyed, but this amount is so small as not seriously to affect the issue. All stores consumed, which are produced in the country, are paid for, and, therefore, not destroyed without compensation.

The writer can think of no other transaction so profitable to the State, because in no other industry is wealth directly created *de novo*. If, for example, £1,000 is invested in breeding cattle, it is usually accepted that in four years those cattle will have doubled their number by natural increase, and hence doubled their value to the State. This equals a usufruct to the State, accruing from breeding cattle, of 25% per annum. In this case also there is a small amount of destruction of wealth (grass, forage, fencing, etc.) which may be taken as equivalent to the destruction of iron in mining.

From the point of view of the world at large—of the human race in general—it is often argued that gold is valueless, as it is only a medium of exchange, not a necessary commodity, and that a mine, especially a gold mine, that does not pay the shareholders is a dead loss to humanity.

With that argument the writer has nothing to do. When the League of Nations has been established and embraces the whole world, then such an argument may carry weight, but at the present time the State is the only unit, and the writer is only concerned with the interests of South Africa, and as far as those interests go it is pure "jargon" to say that gold is merely "a medium of exchange"—it might more truly be described as the elixir of life, the philosopher's stone capable of transmutation at a moment's notice into every element the world produces. A bundle of bank-notes—minted silver and bronze—those are mere media of exchange, for their value depends on credit and a thousand and one causes; but one ounce or one thousand ounces of gold, minted or unminted, is transmutable at a moment's notice at the cost and time taken by a cablegram into any commodity existing in any part of the world.

The cost of the production of gold is also equal to its value. It, therefore, has an intrinsic value equal to its face value and cannot be created at will with a fictitious value, as is the case of notes and silver and bronze currency.

It must be remembered in this connection that "the State" and "the Government" are not synonymous terms; "The State" is the general community within the administrative boundaries of a country and may be called "the Estate of the Government." It is quite possible for a Government to enrich itself temporarily at the expense of the State by injudicious taxation which may bring in an immediate revenue, but which diminishes the capital of the State. In the same way a Government may temporarily impoverish itself by foregoing revenue, or by reinvesting it in permanent improvements, thereby enriching the State.

In the opinion of the writer the questions involved in this discussion are of vital importance to South Africa, for there is a large and growing section of the community who appear to believe that these low grade mines exist purely for the benefit of the promoters, and that, therefore, there is no reason why they should be encouraged by the State, or why they should not be taxed to the breaking point. He, therefore, hopes that this paper may provoke the most complete discussion and that the utmost publicity may be given to it, whether the conclusions arrived at agree, or do not agree, with his own

The President: I am sure we have listened with very great interest to this paper by Mr. Trevor. It certainly affords much food for reflection, and I hope this reflection will result in the most vigorous discussion. I have much pleasure in moving a vote of thanks to Mr. Trevor.

Mr. J. A. Woodburn *(Associate):* I have great pleasure in seconding the vote of thanks to Mr. Trevor for his very comprehensive paper. After listening to this paper, one feels that his task will be rather a heavy one in endeavouring to interest the people overseas in the base metal mining of South Africa, at least with regard to the Pretoria Inspectorate. I think he might have put in one or two clauses to help to modify the conclusions to be drawn from his paper. For instance, a great deal of the total capital he mentions was never spent on actual work on the mines, but was taken up by vendors' shares and other expenditure. In a new country the cost of getting to and opening out a mining property includes a very high cost for travelling, transport, and overhead expenses, in addition to the actual mining work on the ground. To-day, with regard to the Pretoria Inspectorate, a greater proportion of capital would be available for actual development work, as communication is so much easier.

Since 1914, the latest period under review, I know of practically a new gold field in the Pretoria Inspectorate, which may yet prove to be considerably more extensive than is known at present. On one farm, which Mr. Trevor has seen, a new reef has been opened out, and a fairly large quantity of payable ore developed, and at present a 20 stamp mill with suitable cyanide plant is being erected to treat this ore. This property is a considerable distance from any other gold field, and contains a fairly flat reef, which extends through several adjoining farms, and is being opened out and worked by local capital, where the owners are limited to three shareholders. This is one case which is not exactly on a par with some of the mines mentioned by Mr. Trevor, which were floated in the early days on capital which carried a very large proportion of vendors shares, and where the property was put in at a very high value before its actual merits were known. I feel sure that with the knowledge which is now obtained, with regard to base metals in South Africa, properties will yet be opened which, although not so good as some of the very rich plums mentioned, will prove to be sound business propositions.

I have great pleasure in seconding the vote of thanks.

Mr. H. A. White *(Member of Council):* I should like to support this resolution, but I cannot quite agree with what Mr. Woodburn has said as to the effect which is likely to be produced upon the oversea capitalist by the statement of what has happened in the Pretoria District, because I believe that human nature is such that if the prize to be dangled before men's eyes is sufficiently large, no amount of difficulty in the road will prevent a large number of competitors, as Mr. Trevor has shown. He has proved that in the Pretoria District there have been some large prizes.

I consider this paper is particularly suitable and interesting at the present time when we have a Commission sitting dealing with Low Grade Mines, because it must prove to the Government the advantage they will have in keeping these mines running. It has been a question discussed among thoughtful people as to how far the State may intervene with money to support those mines and to keep them working. I do not think anyone can deny that at the very least all the taxation, direct or indirect, which these mines are called upon to stand at the present time, could very safely be refunded, because, when they close down, that taxation would be lost.

There is another point in this paper which I regard as of great importance; it is likely to help to kill that deadly superstition still held in this country that the capitalist is like the old man of the sea, riding on the neck of industry; it clearly illustrates to you the fact that rather he should be regarded as the source of an irrigating stream which is calculated to make the desert bloom and smile.

The vote of thanks was carried by acclamation.

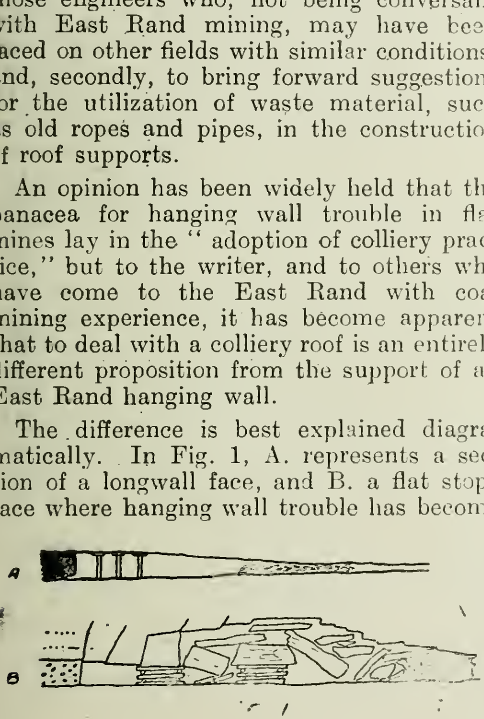
HANGING WALL SUPPORT ON THE FAR EAST RAND.

By L. W. Macer (Associate).

That the problem of the support of hanging wall in the deeper mines of the Far East Rand has engaged the attention of the mining men concerned for some time past is perhaps generally known, and it appears to the writer that the advantage of making the subject one for discussion by this Society should be recognised. The objects of these notes are, firstly, to place the problem before those engineers who, not being conversant with East Rand mining, may have been faced on other fields with similar conditions, and, secondly, to bring forward suggestions for the utilization of waste material, such as old ropes and pipes, in the construction of roof supports.

An opinion has been widely held that the panacea for hanging wall trouble in flat mines lay in the "adoption of colliery practice," but to the writer, and to others who have come to the East Rand with coal mining experience, it has become apparent that to deal with a colliery roof is an entirely different proposition from the support of an East Rand hanging wall.

The difference is best explained diagramatically. In Fig. 1, A. represents a section of a longwall face, and B. a flat stope face where hanging wall trouble has become acutely interesting. The forces acting and the direction of those forces are precisely similar in both cases, yet the effects are very different. The hanging in A. has subsided in a gradual manner, its surface approximating a curve from the coal face to the goaf, whereas in B. cracks have developed at and parallel to the face, and the hanging throughout the stope has broken up and has none of its original stability. The result is the development of a danger zone between the last pack and the face, which means that work has to be carried on in a veritable death trap, whilst in coal mining perhaps the safest place in the mine is at a systematically propped longwall face.



The reasons for the difference in the conditions of hanging wall are:

(a) The difference in the relative rates at which the faces of coal and reef are worked.

(b) The initial resistance of the supports used in the different classes of mining.

The difference in the rate of advance of a stope face and a longwall face is, of course, considerable. A stope face equipped with machines breaking one fathom per machine shift will only advance about 12 ft. per month, the general average for a mine being much less than this, whilst a longwall coal face equipped with disc coal cutters and mechanical conveyors will advance the depth of their cut, namely, 4 ft. 6in. to 5ft. per 24 hours. To the relatively slow advance of a stope face, the writer attributes the difference in stability of roofs, although the heavy blasting and sometimes indiscreet placing of holes in stoping, no doubt, is contributory to the effect.

Coming to the second reason, it is observed that the props used in longwall systematic timbering have a considerable initial resistance, whilst pigstyes used in stoping have practically no initial resistance, in fact their maximum resistance is not reached until they become compressed by about 20% of their original height. This amount of compression is observed at varying, but generally at considerable, distances from the face. The hanging wall is therefore supported at two points, namely, at the point in the stope where the pigstyes have reached their maximum resistance, and at the face. It therefore follows that fracture may be expected at and parallel to the face or in proximity to any pillar left in the stope. Practically, we have the phenomenon of "punching."

The comments to be expected upon the above statements will no doubt be that there is no originality in them; secondly, that stope faces cannot be speeded up; and, thirdly, that props, notwithstanding their initial strength, are impracticable in deep level flat mines; and, finally, that as a cure seems impossible the trouble must be endured. The writer, of course, admits that the difficulties above outlined have been recognised, and that steps have been taken to combat them, and the remaining remarks refer to such improvements as have been already adopted and suggestions for further improvements.

Improved Supports and Methods: Wedged Cogs.—The increase in initial resistance of a pigsty or cog has been to a certain extent effected by driving wedges into the split ends of the lagging of which the pigsty is built. This method is not so effective as might be supposed, and an improved method of wedging without splitting the sticks has been introduced. A split stick (half-round) is placed flat side down in about the centre of the cog. A long wedge of small taper is driven in below the split lagging and rests in a square joggle in the next under-lying stick. By driving home these long wedges the whole of the upper portion of the cog is forced up to the hanging.

Masonry.—Well built dry masonry has been used in preference to pigstyes. A pack 20 feet square with rounded corners is used. These packs, in addition to giving a good initial resistance, resist blasting better than the pigstyes. They are built by experienced masons, and the cost appears to be rather higher than for building cogs. The masons at 20s. per day handle about three tons of stone, which does not, however, compare very favourably with a surface mason's day's work of two and a half cubic yards.

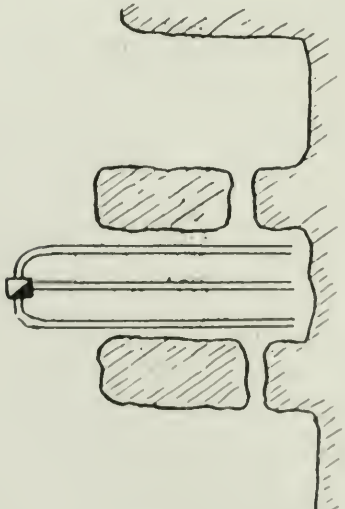


FIG. 2.

Pillars.—The use of pillars in conjunction with the above mentioned supports is the generally recognised practice, notwithstanding that even the greatest advocate of the pillar admits its disadvantages. In deep level mining it is difficult to demonstrate the utility of the pillar except under special circumstances, such as the support of faulted ground or in the process of the reduction of stoping widths.

A method, comparatively recently introduced, known as the "Panel System," makes use of pillars regularly placed and subsequently removed. The system in conjunction with footwall crosscutting is illustrated in Fig. 2. It approximates to the pillar and stall method in colliery work, the stalls being from 70 ft. to 120 ft. wide with pillars of 30 ft. It is undoubtedly the best method of controlling roof weight in a stope where the face advances slowly, and it effectually obviates the dangerous condition mentioned in the earlier portion of this paper.

Suggested improvements in cog construction. — The cog or pigsty has the great advantage over masonry in cost of construction, as comparatively unskilled labour can be used. It has the disadvantage of being easily damaged by blasting unless it is carefully built and unless the stope timberman and machine man work amicably, a condition which it is difficult to obtain in practice.

Fig. 4 illustrates a design which should allow of good construction by an indifferent workman and should result in a pigsty-which it would be difficult to blast out. Four posts are set in such a manner that the ends of the horizontal sticks do not project beyond them. Old wire rope is then passed round the posts as shown in the figure. These ropes are drawn as taut as possible, and finally tightened by means of twisting by the insertion of a piece of pipe or jumper at the point A. The frame is then filled with stone.

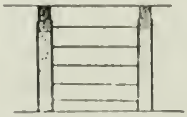


Fig 3

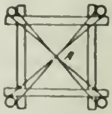


Fig 4

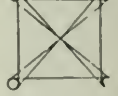


Fig 5

Fig. 5 shows a similar construction, but using wire rope in place of the horizontal sticks.

Fig. 3 uses old pipe filled with concrete for the posts. A plug of wood is used in the upper ends of these posts and answers two purposes. It allows of a certain amount of compression, and can be easily sawn to adapt the length of the post to the height of the stope. Wire rope is again used as in Fig. 5.

In conclusion, it may be mentioned that the question of the support of roof in the East Rand mines would be much more acute if it were not for the fact that owing to unpayability, almost half the area remains unmined. As more mines become worked, however, the roof must become more troublesome and the lay-out of underground workings and methods of mining which have been more or less satisfactory in the past will in all probability be found wanting in the future, and the writer makes this his plea for justification for placing these notes before the Society.

Mr. J. Chilton *(Vice-President):* The subject of hanging wall support is very interesting to all men who go down to the mines, and although the East Rand district has not really reached its troubles yet, still the time will come, and a new method of support may have to be invented for the flat mines of that district.

Mr. Macer speaks of leaving temporary pillars. Some of us in the central area have had a good deal of experience with pillars, and the general opinion is that rigid supports are not only a danger to the persons working round about, but are also a danger to surface property. Almost every earth-tremor, and these are numerous, is caused by the bursting of pillars, and where this does occur the punching effect causes falls of hanging that otherwise would not occur. To my mind, the leaving of pillars is a mistake, apart from the expense of cutting them, and packs are the ideal supports for hanging walls.

It is encouraging to know that the mining people of the East Rand are taking up the idea of roof support and that they are evolving new forms. These pigsties mentioned by Mr. Macer, and which are I believe his own invention, are certainly novel in construction and are probably effective, but of new forms of this support there is no end, each probably limited in its application to the particular mine where invented.

I have great pleasure in moving a vote of thanks to Mr. Macer for his interesting paper.

Mr. J. Gibson *(Associate):* I have much pleasure in seconding the vote of thanks to Mr. Macer for his interesting remarks with regard to methods of supporting the hanging wall in the mines. To those of us who are engaged in actual mining operations, this is a most important subject, and one which has lent itself to numerous discussions, which have probably brought about a good deal of improved practice in supporting the workings in the mines. The question of leaving pillars for support has been a vexed one, and in the Central Rand area has been the cause of a good many serious bursts. Mr. Chilton has had a good deal of experience on the mines of the Central Rand, in connection with which he recently read a very interesting paper on "The removal of the Pillar at the Vertical Shaft on the Village Main Reef." Generally speaking, the practice is to support the hanging wall by less rigid methods than the leaving of solid pillars. This method has been advocated time and time again by different members, and where it has been practised I think it has led to a reduction in serious accidents and probably better mining.

The vote of thanks was agreed to.

NOTES ON ECONOMIES IN HAND DRILL STEEL.

By H. A. Read (Member).

(Printed in Journal, March, 1919).

REPLY TO DISCUSSION.

Mr. H. A. Read *(Member):* It is my pleasure to-night to reply to discussions on the paper entitled "Notes on Economies in Hand Drill Steel" read before this Society last March.

If I have any regret it is that there has been so little discussion. I understand, however, that it is customary for the author on such occasions to give any supplementary information which may be available.

But I first wish to touch on a point raised by Mr. Hildick-Smith, who deprecated the genesis of my investigation which, you will remember, I attributed to curiosity. Now, in contra distinction to Mr. Hildick-Smith's views, I hold that curiosity may, in certain circumstances, rank with discontent, which we are told is divine. You will recall that Kipling wrote a children's story explaining "How the elephant got his trunk"—through "insatiable curtiosity." The laws of gravity, if I rightly remember, were, according to tradition, discovered as the result of curiosity. Personally, I have nothing but respect for the people who move round asking "the why?" with its American relative "the how" of things. Curiosity is sometimes like necessity—the mother of invention, and such maternity should be encouraged.

I was pleased to see from Mr. Payne's remarks in April last that he was able to corroborate a good deal of the information which I gave as to the consumption of steel, and I should be glad to hear whether he has been able to try the invention on his mine. My own ideas certainly run to further efforts to produce a more workmanlike hand-drill than is at present in use. One of my mining friends mentioned that he had found, much to his surprise, that, in certain classes of rock, blunt steel appeared to drill better than sharp steel. This sounds rather paradoxical, but it was, I believe, borne out by some other experiments some years ago. This point might be looked into.

It seems to me possible, also that the drill might consist of a fluted shaft having a permanent head and a short bit of very high grade steel, provided that a sufficiently satisfactory weld of the high grade steel on to the low grade steel can be secured, say, by the oxy-acetylene process. The amount of work involved in transporting steel backwards and forwards for sharpening and the expense consequently involved appears to me to make this suggestion worth considering.

Since I addressed you I have been able to secure some particulars of the results of hand-drilling with my improved hand drill on two companies, viz., the New Kleinfontein and the Durban Roodepoort Deep. The results at the Durban Roodepoort Deep I tabulate as follows:—

	10 months without improved head.	8 months with improved head.	
Average No. of natives working	825	640	
Stoping width	16·7 inches	14·9 inches	
Decrease		1·10 ,,	= 2.1%
Tons per native per 26 shifts	27·172 tons	29·533 tons	
Increase		2·361 ,,	= 8.7%
Fathoms per native per 26 shifts	2·321 fathoms	2·630 fathoms	
Increase		0·309 ,,	= 13·3%
Native pay per shift ...	2/-	2s. 3d	
Increase		3d.	= 12·5%

At the New Kleinfontein the fathomage results were as follows:—

	6 months without improved head.	11 months with improved head.
Fathoms per native per 26 shifts ...	0·1698	0·18304
Increase ...		0·01324 = 8%

The New Kleinfontein steel figures for the six months, January to June, 1919, compared with the figures January to June, 1918, are also instructive:—

	Without improved drill. Jan. to June, 1918.	With improved drill. Jan. to June, 1919.
lbs. new steel issued	93,128	38,579
lbs. steel remade	——	29,258
	93,128	67,837
Cost per lb. (1919 new prices ...	9·825d.	9·825d.
Value	£3,812 8 6	£2,777 1 7
Cost per ton	2·619d.	2·130d.
Saving for 6 months ...		£1,035 0 0

I am not in a position to do more than draw the general inference from these figures that the increased efficiency has been due to a large extent to that diversion of energy which I claim for the improved drill. There may, of course, have been contributory causes, but of these I have no details.

You will recall that originally I gave you figures showing what a 5% increase in efficiency meant. It is, at any rate, remarkable that bulk figures from two mines so far apart as the New Kleinfontein and the Durban Roodepoort Deep should show similar results. I leave to you the simple arithmetic required to ascertain the difference in value to this industry between an increase in efficiency of 5% and the increase of, say, 10%, the approximate average figure shown by these two companies.

As many of you are probably aware, very encouraging results have been obtained on certain companies by reducing the section of the steel used in drilling to ¾ in. in place of ⅞ in., and by using a 3 lb. hammer in place of a 4 lb. hammer. This originated at the City & Suburban Gold Mining & Estate Company, Limited, where the initial results showed a marked improvement. At first the drills were not equipped with permanent heads, but, about a month after the experiments started, I understand that this was done. It is open to question whether ¾ in. steel can be efficiently used without the head. It has, I am told, been tried in the past and has been abandoned owing to the rapid peeling down of the steel. That increased work should be got with ¾ in. steel is logical, as the following figures will show:—

⅞" Steel.	Gauge.	Area of Attack.	¾" Steel	Gauge.	Area of Attack.	Percentage Reduction in area of attack, i.e. superficial area of hole drilled.
Starter ...	1-7/16"	1.62	Starter ...	1-1/4"	1.23	24.1%
2nd Drill ...	1-5/16"	1.35	2nd Drill ...	1-1/8"	0.99	26.7%
3rd Drill ...	1-3/16"	1.11	3rd Drill ...	1"	0.78	29.7%
Long Drill...	1-1/16"	0.89	Long Drill...	7/8"	0.60	33.3%

As to the correct depth of hole, breaking efficiency, and ultimate cost per fathom under varying mining conditions, I am unable to express an opinion. It would, doubtless, vary from mine to mine. Probably the use of higher grade explosives may give as good breaking in the smaller hole made by ¾ in. steel. This is a problem for the mining engineer to solve.

Another point is the question of the greater consumption of hammers. It has been suggested that it is of importance. On the basis of such observations as I have been able to make, I am not in agreement with this view. If a mine re-conditions its hammers, I think it will be admitted that errors of tempering are likely to arise under the somewhat empirical methods usually adopted, which will tend to the production of hammers variable in quality and generally incapable of standing up to the work. The issues of new hammers at the Ferreira Deep and the Durban Roodepoort Deep over the periods covered by the figures previously given, do not disclose any abnormal consumption. When it is recalled that the hammer in the hammer type of rock drill strikes, say, 1,200 to 1,800 blows per minute over long periods, it will, I think, be admitted that it ought to be possible to produce a hammer sufficiently well tempered to stand up to hand work. This is a matter for hammer makers; we might, in fact, ask them to keep their tempers!

As a final point, it may be mentioned that it appears to be common practice for natives when they find their drills badly "mushroomed" to beat off the jagged ends. These fragments of steel thus mix with the fines and a proportion would pass into the mill and thence into the metallurgical works. I have consulted some of my metallurgical friends, who agree that the presence of rusty fragments of steel would tend to increase cyanide consumption. I leave the suggestion to them for consideration.

CHEMICAL ENGINEERING.

By J. A. Wilkinson, M.A., F.C.S.
(Past-President).

(Printed in Journal, March, 1919.)

REPLY TO DISCUSSION.

Prof. J. A. Wilkinson *(Past-President)*: The great interest which is being displayed in other parts of the world, notably in England and America, in the subject with which this paper deals, would appear to be conspicuous by its absence in this sub-continent. I had hoped that a subject of such importance, even though dealt with in a somewhat cursory manner considering its magnitude, would have elicited a greater amount of criticism and discussion than that which has been given to it.

The President (Mr. H. S. Meyer) considered my views somewhat idealistic, and the only comment which it is possible to make on this statement is a request to make himself acquainted with what is being and has been accomplished elsewhere, especially in Germany and America, and I feel sure that his ideas about my ideals will quickly vanish. It is impossible to think that anyone here would doubt the truth of the statement that chemical industry is a necessity, vital not only to the prosperity of a nation, but even to its merest existence, and, if this be the case, surely it is equally necessary to provide the fullest equipment possible for training those who desire to make this their life work.

Mr. Cazalet's fear that a student, who has passed through such a course as that outlined, will be a jack of all trades, is one that has been often expressed in discussions on this and also other branches of engineering study. When a student enters on his engineering work, he should at the same time be able to select the particular branch in which he desires to attain proficiency, and his course is then mapped out accordingly. For example, the design and construction of bridges is a subject upon which a chemical engineer would be wasting his time, and no civil engineer would ever attempt to study the evaporation factor of a vacuum pan. I entirely and emphatically agree with Mr. Cazalet that it is not the function of the chemical engineer to be able to manufacture all his plant. What it is necessary for him to do is to be able to design and assemble the plant required for the chemical operations which are to be undertaken. His knowledge of the steam engine or other prime movers should be such that he can state exactly what he requires from the mechanical engineer and similarly with regard to dynamos and motors from the electrical engineer. When these have been supplied, he should have the knowledge of their practical use, his chief concern being the control of the chemical factors and operations to which these are necessary.

I am indebted to Dr. Caldecott for the valuable additional references and quotations he has given stating the views of distinguished English chemists on this subject and also for the instructive and trenchant article of Mr. Barham, published by him in the Abstracts. Since the appearance of this article last January, a Commission of English chemists appointed by the British Government has visited the large chemical factories in the occupied area on the Rhine. The very brief statements that have since appeared in the scientific press as a result of this visit are sufficient proof of the importance of the necessity for the fullest provisions for training chemical engineers and their value to the community not only in peace but in war. The comments made by Dr. Caldecott on the use to which a chemical engineering laboratory could be put in this country I fully endorse, owing to the fact that its assistance is required in the solution of problems with which one is so often brought into contact here, and when placed in circumstances, such as these, the need for the existence of such provision is keenly felt.

With Mr. McArthur Johnston's remarks on the lack of chemical knowledge by the engineers on our mines I fully sympathise, and at the same time agree that a compulsory paper on chemistry in the examination for certificates of competency would be a step in the right direction. This, however, should be of a standard commensurate with the importance of the subject, as a little knowledge could easily prove more than dangerous. The chief effect, in my opinion, of such a step would lie not in the mere gain of chemical knowledge, but rather in the appreciation of the chemist's work by the engineer, which would lead at once to that hearty co-operation so necessary for true efficiency.

With respect to the time being devoted to general principles rather than to specialised study, I would remind my critic that a curriculum has to be drawn up so as to fit in the course into a limited period of four years, and it is the considered opinion of those who are responsible for such courses that it is impossible with advantage to the student to specialise in such a period considering the number of necessary subjects which require to be dealt with. At the present moment the medical curriculum in Great Britain covers five years and in South Africa six years. When an extension of time is granted in the engineering courses, a desideratum such as specialised study in one branch will become possible. In conclusion I desire to extend my thanks to those gentlemen who realize the importance of this subject and have in the main supported my contribution by welcome criticisms.

NOTES ON DEFECTIVE AIR IN DISUSED RAISES AND BACKSTOPES.

By C. J. Gray (Member of Council).

(Printed in Journal, May, 1919).

DISCUSSION.

Mr. J. Chilton *(Vice-President):* It has long been a common opinion among Rand miners that the only gas to be feared in raises and backstopes was nitrous fumes. Mr. C. J. Gray's excellent paper dispels this view, and adds appreciably to our knowledge of the deadly mixtures that may be met with in places remote from ventilating currents. Black damp which, according to Dr. Haldane, is a composition of 86% nitrogen and 14% CO_2 will usually be found lying along the floor of the working place with air above it, being 4% to 5% heavier, may when actually met with in unventilated places, such as raises and backstopes, be lighter than air in consequence of admixture with firedamp. Such mixture, unless in considerable quantities (10 per cent. or more) will probably not be detected with an ordinary lamp. The flame will simply be extinguished without previously showing a cap. In the Wolhuter accident it is possible that the oxygen deficiency might be due to the presence of methane, for although this gas has no poisonous action, it will not support life. Accidents due to methane or firedamp are fortunately very rare in Witwatersrand mines, yet such do occur, and outbursts of explosive gases are more common than is generally supposed. The writer had a somewhat unusual experience a few months ago in one of the old mines in the Rand central area. A holing was expected in a drive that had not been entered for over two years, and a shift-boss, a former coal miner, was ordered to examine this drive. He returned with the information that examination was impossible owing to the presence of methane. Much doubt was expressed as to the correctness of this report, but further examination confirmed the shift-boss's opinion, for fire-damp was undoubtedly present, and an accident was only prevented by a rapid retreat into more healthy regions. There is little doubt that if the explorers had persisted in their intention to see the end of the drive they would both have been suffocated, and their death would have been due to deficiency of oxygen.

It is possible that the defective air might be due to an outburst of carbonic acid gas. In European mines these are frequent, and in every respect similar to those of firedamp. Hughes records such an occurrence at the Toulane Colliery, Rochebelle, where a blower of carbonic acid gas filled 500,000 cubic feet of workings in less than ten minutes. The writer is aware of a similar case that took place in an East Rand mine some years ago. At a depth of over 3,000 ft. a developing drive intersected an open fault containing water under a very high pressure. As soon as the drill pierced the fault, water heavily charged with carbonic acid gas was liberated and all lights went out, and it became impossible to get or retain a light in that drive for some weeks. The gas flowed out in a stream about 3 ft. in depth till it met the main ventilating current and was swept away. It appeared to the writer that as the waters percolate through they are subject to a constantly increasing pressure head; carbon dioxide is soluble under ordinary pressure in the proportion of one volume of gas to an equal volume of water, and its solubility increases as the pressure increases. It follows therefore that when this water was liberated at the fault and the pressure head was reduced, every cubic foot of the water freed several times its volume in gas, the quantity being proportional to the pressure to which the water was subjected. In this case the drive was fenced off till both gas and water had ceased, but till then there always existed a fear that some adventurous native would pass the fence and find an easy death entirely due to deficiency in oxygen. Although lights become extinct with 16% CO_2 and the gas becomes deadly at 25%, most mines have not been able to discover any means to readily determine when the latter point has been reached.

Mr. Gray's excellent paper brings forward a subject that of interest not only to the mining and chemical members of this society, but one in which even the metallurgists may find something of interest.

THE SOLUBILITY OF GOLD IN CYANIDE SOLUTIONS.

By H. A. White (Member of Council).

(Printed in Journal, July, 1919.)

DISCUSSION.

Mr. J. Hayward Johnson *(Member of Council):* It would be interesting if Mr. White, in his reply, gave us the strength of the solution he is using as a dissolvent in his slime plant (he states on page 3 (1) " Solution entering slime boxes KCy 0·010% (free) "), and elucidate the reason of stronger solution being necessary in sand treatment than slime treatment, where a very weak solution, as low as 0·005% KCy (free) will dissolve the gold and give as good an extraction as in sand treatment using 0·025% to 0·03% KCy which evidently, by his experiments, gives the best results. Of course, it is understood that the dissolution of gold is more rapid in slime than sand owing to the gold being in a finer state of division and the aeration that is obtained in transferring, circulating, etc., of a slime charge.

In the outside districts I found it more advantageous to use, as a first wash, solution made up to a strength of 0·005% KCy than anything stronger, not only from the economic point of solution being discharged with the slime, but from the fact that the destruction of cyanide was considerably less with the weaker strength (0·005%), and the dissolving of gold was as good, and even better, than with stronger solution. This has been further confirmed on my return to the Roodepoort and Maraisburg districts. The question, therefore, arises whether it would not be possible to do as good work on a modern sand plant (where the pulp is reduced to a fineness of 80% to 90% – 90 (0·006″), a complete as possible classification of sand from slime, facilities of draining dry, by means of vacuum pump, after each saturation, and by this means obtaining as much aeration of the product as possible) with a solution of 0·01% KCy (free) as with the 0·025% to 0·03% strength demonstrated in Mr. White's very interesting and instructive paper.

Mr. A. King *(Member of Council)*: I have not been able to prepare a contribution on this paper, one reason being that Mr. White has covered his subject very exhaustively and has left little room for criticisms or suggestion, but I should like to add a word of congratulation to what has already been said about the work Mr. White is doing. I should not like the author to feel, although there may be no criticism coming forward on the papers he has recently given, that cyanide managers are not appreciating the work he is doing and continuing to do. Those who are in touch with that work know that Mr. White's researches are highly appreciated by many of the members of the Society, and there is no doubt that his work and the paper which he submitted to our Society something over a year ago on the " Determination of Oxygen in Cyanide Solutions " were largely the cause of the important experiments which are being carried out at the City Deep.

One point I might mention in connection with what the last speaker has said. My experience of slime treatment is perhaps somewhat unusual in connection with cyanide and oxygen content of solution. I find that, even with the impure water which we have to use, we get our gold dissolved with a comparatively low strength of cyanide, and that after agitation, circulation, and so on, there is about four or five mgm. of oxygen per litre dissolved in the solution, but, by the time that same charge has settled and is ready for decantation, that oxygen has disappeared, due no doubt to the impure water. It is a point worth noting that though one may have a very low strength of cyanide (say 0·005%), provided there is sufficient oxygen there during agitation, the gold will be dissolved and quite good residues be obtained. Naturally, under these conditions practically no white precipitate is found in the extractor boxes in which we precipitate slime plant solutions. I feel sure that many members are looking forward to having further results of Mr. White's researches.

The meeting then terminated.

Notices and Abstracts of Articles and Papers.

CHEMISTRY.

Determining Dissolved Oxygen in Water.—"The determination for dissolved oxygen is not usually made in the examination of water, but in the making up of standard solutions for oxidizing purposes the oxygen content of the water used should be known. The latter is only necessary in the most accurate work. The solutions used are: potassium permanganate, 4 gm. per litre; potassium oxalate, saturated solution; sulphuric acid, 1 to 5 or 6; manganous sulphate, 350 gm. per litre; alkaline potassium iodide, 400 gm. KOH, 150 gm. KI to make a litre of solution; N/40 sodium thiosulphate solution.

The sample is collected in a 100- or 200-cc. bottle the volume of which is known. Care must be taken that all the air originally in the bottle is completely removed before stoppering the bottle. If the sample is collected from a pond, or like source, it should be sunk beneath the surface, or if from a tap, a hose should be run to the bottom of the bottle and the water allowed to flow for at least 5 minutes. One cc. each of permanaganate and acid should then be added, using a long narrow tube, releasing it at the bottom of the bottle. The stopper is replaced, the bottle well shaken and allowed to stand for 20 minutes provided the colour persists that long; if not, more permanganate is added. At the end of that time enough oxalate to decolorize it on standing a short time is added. The purpose of the process is to destroy any nitrite which may be present.

Two cc. each of manganous sulphate and alkaline iodide are then added in the same manner, and the bottle is stoppered and shaken and set aside for the precipitate to settle. Enough acid, about 3 cc., to dissolve the precipitate is then added. The solution is then poured into an Erlenmeyer flask and titrated at once, using the standard thiosulphate solution, with a starch indicator $N/40$ thiosulphate is equal to 0·0002 gm. of oxygen per cc., so the oxygen content of the bottle is $200\ N/V$, N being the number of cc. used to titrate, and V the volume of the bottle. The percentage of saturation is $20000N/VO$, O being the solubility of oxygen in water at the particular temperature at which the sample was collected.

As the sample rapidly assumes the temperature of the air, the manganous and manganic hydrate should be precipitated as soon after collection as possible. After precipitation, it may stand some time without harm. After the liberation of the iodine, it should be titrated immediately, as standing in light decreases the iodine content and standing in the dark increases it.

To determine the oxygen content of the reagents, a blank may be run, using oxygen-free water. This is prepared by precipitating manganous hydrate in a large bottle of water and allowing it to stand. The manganous hydrate gradually is oxidized to a mixture of the -ous and -ic hydrates. The sample should be taken from the bottom, using a bulb and a tube extending to the bottom of the bottle. This blank is seldom necessary, as the amounts used of the reagents are small and the oxygen in them is generally low."—Isaac S. Guest.—*Engineering and Mining Journal*, Feb. 1, 1919, p. 241. (H. A. W.)

Crude Sodium Cyanide and Process of Producing Same.—"(*a*) An intimate mixture of calcium cyanimide, sodium chloride, and finely divided (chemically active) carbon—the latter having been previously heated to not more than 1,000° C.—is heated to a temperature sufficient to produce sodium cyanide. Crude products obtained by this means, and containing more than 20% and more than 32% by weight of sodium cyanide respectively, are claimed. (*b*) An electric furnace for making sodium cyanide from 'lime nitrogen' (crude calcium cyanimide) and sodium chloride has a hearth of conducting material (which forms the lower electrode) and a funnel-shaped shaft, at the apex of which a small crucible chamber is situated within the hearth. The upper graphite electrode depends within the shaft, is adjustable vertically, and serves to restrict the passage of the charge from the shaft to the crucible chamber. A tap-hole is provided for removing the sodium cyanide produced. (*c*) A mixture of calcium cyanimide, sodium chloride, and carbon or calcium carbide is fed continuously into the shaft of the furnace described under (*b*), and through the restricted portion of the mixture within the crucible chamber a current density is maintained sufficient to produce sodium cyanide without causing foaming of the charge."—H. Freeman, Niagara Falls, Ont., Assignor to American Cyanimide Co., New York; U.S. Pats. (*a*) 1,277,898, (*b*) 1,277,899, and (*c*) 1,277,900,3.9.18; Appls., 29.11.16, 20.4, and 23.4.18.—*Journal of the Society of Chemical Industry*, Dec. 16, 1918, p. 733a. (J. A. W.)

METALLURGY.

Economical Treatment of Tin Ores.—"Practically the whole of the tin ore output of the British Isles has been derived from the Cornwall and Devonshire mines. There is a considerable loss in the treatment of tin ores estimated at about 35 per cent., which may possibly be lessened with improved methods. Unless values can be increased by improved methods, several of the mines will probably have to shut down when the price of tin returns to its former level.

In a paper, published by the *Institution of Mining and Metallurgy* by request of the *Tin and Tungsten Research Committee*, Mr. Yates investigates the effects of heating and quenching before crushing. The object was to see how this treatment would (a) Assist the operation of crushing; (b) Diminish the breaking up of coarse particles of cassiterite, and the production of slime; (c) Facilitate the liberation of particles of cassiterite from the accompanying gangue, and thus render possible an increased recovery by concentration.

All the tests show that the effect of heating, and still more of heating and quenching, is to make the ore much easier to crush. The effects of these treatments are, to yield crushed products with greater proportions of middle sized particles, and smaller proportions of those fine slimes from which very little tin can be recovered. These results confirm similar observations made by Stadler, which led him to urge that in treating tin slimes, the first step should be to separate as far as possible the very fine slime from which very little recovery of tin could be expected, and which by its presence would hamper the successful treatment of the more granular fine material."—H. L. Lockley, *The Engineering Review*, January 15th, 1919, p. 192. (J. J. R. S.)

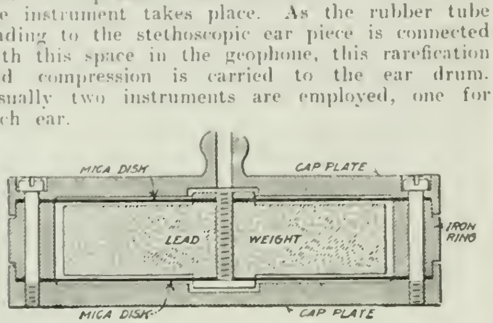
MINING.

The Geophone.—"The geophone, a "listening" instrument invented by the French to detect enemy sapping and underground mining operations and for ascertaining the position of enemy artillery, is now being used by the Bureau of Mines as a possible aid in establishing the location of miners who have been entombed after a disaster. The instrument was developed by United States engineers during the war, and is now used by the Bureau according to plans drawn by these engineers.

Alan Leighton, assistant chemist of the Bureau, who has now charge of these investigations, has given the following statement of general information regarding the geophone:

The instrument, though small, is essentially a seismograph. It consists of an iron ring about $3\frac{1}{2}$ in. in diameter, within the centre of which is supended a lead disk which is fastened by a single bolt through two mica discs, one of which covers the top and the other the bottom of the ring. There are, in addition, two brass cap pieces, the top one having an opening in its centre, to which is fastened a rubber tube, leading to a stethoscopic ear piece. The cap pieces are fastened with bolts to the iron ring and serve also to hold the mica discs in place.

If the instrument is placed on the ground, and any one is pounding or digging in the vicinity, energy is transmitted as wave motion to the earth, and the earth-waves shake the geophone case. The lead weight, on account of its mass and because it is suspended between the mica sheets, remains comparatively motionless. The result is that a compression and rarefication of the air in the instrument takes place. As the rubber tube leading to the stethoscopic ear piece is connected with this space in the geophone, this rarefication and compression is carried to the ear drum. Usually two instruments are employed, one for each ear.



Detail of Geophone Construction.

When the two instruments are used, it has been found that the sound is apparently louder from the instrument nearer to its source. It is evident, then, that by moving the instruments properly a point can be found when the sound will be of the same apparent intensity in both ears. The direction of the sound is then on a perpendicular to the line connecting the centres of the two instruments either in front of or behind the observer. Further observation will show which side. Approximate direction is then accurately determined.

During the period of the war, engineers of the Mining Division of the Bureau of Mines were engaged in determining the distance through the clay, shale, coal, and the mine cover that different mining machines could be heard. Measurements were made, also, of the energy required in blows that could be heard for definite distances through clay, shale, and coal, as well as the distances at which the shock waves resulting from the discharge of various explosives could be audibly recorded.

In this connection it was found that sounds were transmitted only about half as far in clay as in shale strata, and about one quarter as far in clay as in coal. The sensitiveness of the instrument is such that pounding with a pick on the bituminous coal can be detected for a distance of 900 ft., and the direction determined, and pounding with a sledge can be heard as far as 1,150 ft. These measurements were made in the Pittsburgh coal seam in the vicinity of Pittsburgh, where the coal is somewhat harder than in most other bituminous coal beds. The explosion of a 1 oz. charge of dynamite was detected a distance of 2,000 ft. through shale strata. One interesting feature of the instruments is that the sound is transmitted to the ear is markedly characteristic of the instrument producing the sound.

It is thought that the geophone will be of value to mine rescue crews who may be entering mines for exploration and for the purpose of finding miners who may have been entombed after a disaster. The tests so far made in the vicinity of Pittsburgh show that a man pounding on the coal rib with a pick, piece of timber, or a sledge can be detected and his position determined from a point of 600 to 1,200 ft. distant. The distance depends mainly on the character of the coal upon which the man is pounding, and intervening rooms and entries seem to have surprisngly little effect upon the distance or the determination of direction.

Pounding with a sledge can be heard from 200 to 300 ft. through the mine cover, the distance depending upon climatic conditions, as wind interferes greatly with the successful operation of the instruments. A study is also being made of the distances that pounding on rails and pipes can be heard. As rails are generally buried in the earth or dust on the entries of a mine, and because this dust damps the transmission of the sound, it is not transmitted well. The same is true of pipe lines. However, if pipe lines are not buried, but are laid on blocks and ties, pounding can be heard for great distances. So far no lines have been found long enough to show the limit of the geophones. It is known, however, that the ear can detect, without artificial aid, sounds made more than 2,000 ft. distant.

In metal mines, expensive surveys sometimes have to be made, so that approaching tunnel headings may be brought together accurately. As direction can be determined so well with the geophones, it is thought that they can be utilized to advantage to guide such work. It would simply be necessary to go into each heading and determine the direction from which pounding in the other heading was coming."—*Engineering and Mining Journal*, May 17, 1919, p. 872. (H. A. W.)

MISCELLANEOUS.

Conveyors.—"The belt-conveyor is an exceedingly simple and efficient carrier of loose material that is to be handled in a continuous stream and in large quantities. Grain, ore, coke, coal, and gravel are economically transported in this way. However, it is not necessary that the material be in loose form; filled sacks, loaded boxes, packages of various sizes, and even bundles of magazines, as practised by some of the largest publishing houses in the country, are handled by belt-conveyors. Within certain limits belt-conveyors can be used for elevating material. An interesting illustration of this use is to be seen in the crushing department of the new leaching-plant of the Utah Copper Co. The conveyors here are installed between the gyratory crusher, two sets of rolls in series, and the storage-bin, thus eliminating the troublesome bucket-elevator. Though belt-conveyors can be loaded or unloaded at any point along their length, the most economical operation requires that they should be loaded at one end and discharged at the other. When properly installed and cared for they are reliable, and their flexibility, as well as their large capacity, makes them a satisfactory means of transporting material. Where a steady and continuous delivery of material is desired the belt-conveyor is unequalled by any other device. It is not an efficient machine for intermittent work, nor is it to be recommended where the discharge must occur at a number of points, because heavy wear is entailed by several trippers. The belt should always be loaded to its capacity.

Detail of Belt.—A rubber-covered belt is generally used. Steel bands, woven cotton, and stitched canvas, have been tried, but have not proved satisfactory for handling wet material. Belt-conveyors are sooner or later subjected to the action of moisture, in mining work, and only rubber-covered belts will resist moisture successfully. Balata, a vegetal gum from Venezuela and the Dutch East Indies, is similar to rubber, but has greater tensile strength and deteriorates but slowly. However, its higher cost and the careful manner in which it must be worked, have operated against its extensive use.

Belts are made by covering a layer of duck with rubber, or 'friction,' as it is called. The duck is then cut to the desired width, the requisite number of plies are placed together and the rubber cover is laid on. The finished belt is then made by running the whole through the vulcanizing press, the heat and pressure making a compact and solid belt. The tensile strength of a belt depends upon the weight of the duck used in its manufacture. Duck comes in weights ranging from 28 to 36 oz., the weight applying to a piece 42 in. wide by 36 in. long. A first-class belt should contain nothing lighter than 30-oz. duck. The life of a belt depends upon the protection offered by the rubber cover in keeping out the moisture, which, having once entered the canvas, causes the plies to separate and the cover to loosen or blister, and to lessen the strength of the 'friction' to hold the plies together, especially when passing around the pulleys.

It is not a difficult matter to keep an accurate account of the performance of any belt-conveyor nor to make a few informing tests on a new belt, yet it is not often that an authentic record of performance can be found. The data obtained are generally carried in the head of the foreman or superintendent of the plant, and are often unreliable because of personal prejudice in favour of or against the goods of a certain manufacturer. A good form of record, proposed by the B. F. Goodrich Co., is shown below.

Company	Place where used ... .
Plant	Conveyor ....

Width of belt	Material	Sketch of conveyor.
Length of belt	Maximum size	
Number of plies ...	Minimum size	
Top cover	Wet or dry	
Back Cover	Average hours per day ...	
Furnished by	Speed	
Order number	Drive	
Manufacturer	Load applied at	
Brand	Number of loading points...	
Price per foot	Length centre to centre ...	
Date received	Difference in elevation	
Date put on	Angle of incline	
Date taken off	Trippers	
Length of service...		
Cost of belt		
Repairs: Labour ...		
Material...		
Total cost		
Total tons handled		
Cost per ton		

The following tests, recommended by the Robins Conveying Belt Co., can be carried out by means of a spring-balance, small clamps, and a cutting-die for the rubber cover,

1, Binding strength of the 'friction.' Cut from the end of the belt a strip exactly one inch wide. Commence at the back or bottom of the strip and about three inches from one end, after marking on the strip, with ink, distances one inch apart; cut and pry loose the outer ply for about one inch. Hook the spring-balance into the ply and pull with the balance until a weight equal to the specified strength of friction is indicated. With this tension kept uniform, the rate of separation of the plies should not exceed one inch per minute.

2. The strength of adhesion of the rubber cover is found in the same way.

3. Strength and elasticity of the rubber cover. For this test remove a piece of the cover and cut it, by means of the die, the size and shape shown in Fig. 1. Gauge the thickness with a micrometer, allowing for projections caused by the impressions of the duck on the under side. Mark with ink on the strip a distance of two inches. Attach clamps and apply a steady pull until the two marks have been stretched apart a specified distance, say from four to six inches. Relax the tension, and immediately measure the distance between the marks. The increase over two inches is the 'immediate set,' which should not exceed the specified amount. The tensile strength of the cover is next obtained by stretching until the piece breaks. If P is the pull in pounds shown on the balance at the time of breaking, and T is the thickness in inches of the cover, the tensile strength per square inch, the strip being $\frac{1}{2}$ in. wide, is

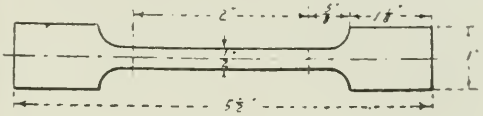


Fig. 1.—Cutting Die.

$$S = \frac{2P}{T}$$

4. Strength of duck.—This can be determined only in a testing-machine. Manufacturers will give this value upon request.

The exact value of the data obtained changes with the kind and make of belt tested, and is a matter of specification with the manufacturer. Records of tests compared with the performance of belt will indicate how a belt can be judged before it is used. In regard to the first test, it may be said that poor belts will begin to strip under a pull of 7 lb. or 8 lb. per square inch. A well-made belt may show a resistance as high as 26 lb.; a good average is 16. A belt should be made for the particular work it is to do; consequently one set of specifications will not serve for all belts. The tests will show whether a belt comes up to the specifications.

Stepped belts have a greater number of plies at the edge than at the middle, and the rubber cover is correspondingly thicker at the centre of the belt. This construction makes a belt that is very resistant to abrasion and one that does not bend greatly between the troughing idlers. Roughly speaking, belts with a $\frac{1}{8}$ in. rubber cover at the centre have plies at this point one less in number than at the edges. Belts with a 3-16 in. cover at the centre have a difference of two in the number of the plies between the centre and the edges. Where the difference in plies is two, the belt may be considered as the equivalent of a straight belt having one less than the maximum number of plies at the edges. Thus a 40-in. stepped-belt of 9 and 11 plies would be equivalent to a straight belt of 10 plies.

The following table gives the weight in pounds per foot of straight belts with $\frac{1}{8}$ in. cover, as prepared by the Robins Conveying Belt Company.

Width, inches	Number of Plies. 3	4	5	6	7	8
12	2·4	2·6	2·8	..		...
14	2·7	3·0	3·3	3·6	...	..
16	3·0	3·4	3·8	4·1	..	...
18	3·4	3·8	4·2	4·7	5·1	...
20	3·7	4·2	4·7	5·2	5·6	6·1
22		4·7	5·2	5·7	6·2	6·7
24		5·1	5·7	6·2	6·8	7·4
26		5·5	6·1	6·7	7·3	8·0
28		..	6·6	7·3	7·9	8·6
30			7·1	7·8	8·5	9·2
32			7·6	8·3	9·1	9·8
34			8·0	8·8	9·6	10·4
36			8·5	9·3	10·2	11·0
38			9·0	9·8	10·7	11·7
40			9·4	10·4	11·3	12·3
42			9·9	10·9	11·9	12·9
44			10·3	11·4	12·4	13·5
46		..	10·8	11·9	13·0	14·1
48		..	11·3	12·4	13·6	14·7

Width of Belt.—Three factors must be considered in determining the width of a belt : the size of the largest piece carried, the speed of the belt, and its capacity. Where large lumps are to be carried, their size, rather than the number of tons per hour to be transported, fixes the width of the belt. Obviously, the capacity of a belt varies with the speed. The relation between these factors is shown in the following equation :

$$\frac{c_1}{c_2} = \frac{v_1 (w_1)^2}{v_2 (w_2)^2}$$

where c = capacity in tons per hour, v = velocity in feet per minute, and w = width of belt in inches. Thus, for two belts run at the same speed their capacities vary as the square of their widths.

Pulleys and Drives.—All pulleys should be at least two inches wider than the belt. Owing to their slow speed and the heavy stresses to which they are subjected, pulleys should be made extra heavy and in a single piece. Sectionalized pulleys are a never-failing source of trouble. For heavy drives lagged pulleys are best. Rubber lagging increases the tractive force of pulleys nearly 40%, and is generally used unless the material handled is very wet, in which case wood lagging is to be preferred. Heavy keys and two set screws, one over the key and one on the shaft, ensures a solid fastening to the driving shaft.

As mentioned above, the bending stresses in a belt as it passes round a pulley, shorten its life, just as bending around the head sheave affects the lift of a hoisting rope; consequently pulleys of small diameter should be avoided. A good rule is to have the diameter of the pulleys not less than 5 or 6 in. for each ply of belt. A three-ply belt would then have a pulley of from 15 to 18 in. diameter. Some engineers recommend a diameter of 8 in. per ply.

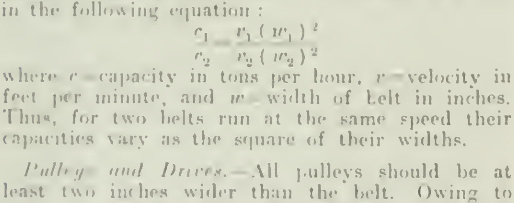


FIG. 2.—*Types of Conveyor Drives.*

The conveyor-drive is most commonly placed at the head or discharge end, though, if necessary, the drive may be placed at the tail end or at any intermediate point. Four types of drive are in general use ; single bare pulley, single lagged pulley, double bare pulleys, and double lagged pulleys. Some arrangements of pulleys are shown in the sketches on the preceding page.

Capacities, Plies, and Horse-Power.—Examples of charts for the determination of these factors as devised by the Robins Conveying Belt Co., are given.

The following formulas are given by the B. F. Goodrich Company :

Let p = correct number plies.
k = constant depending upon type of drive.
g = weight of material in pounds per cub. ft.
W = belt width in inches.
L = total length of belt in feet (roughly twice the distance between centres).
H = difference in elevation between head and tail pulleys in feet.
U = capacity in tons per hour.
S = speed in feet per minute.
HP = horse-power developed in driving the belt.
L' = length of conveyor in feet, or ½ L.
T = total tension in belt in pounds.
C = constant depending upon type of drive.

$$(1) \qquad p = k\,g\,W\,(L + 10H)$$

$$(2) \qquad U = \frac{0.08\,W^2\,S\,g}{5000}$$

$$(3) \qquad T = \frac{C \times HP \times 100}{S}$$

$$(4) \qquad HP = \left(\frac{0.02\,L^1}{100} + \frac{0.01\,H}{10}\right) U$$

$$(5) \qquad p = \frac{T}{24\,W}$$

Type of drive.	Value of k.	Value of C.
Simple bare pulley	1/250,000	600
Simple lagged pulley ..	1/300,000	500
Tandem bare pulley	1/375,000	400
Tandem lagged pulley ...	1/445,000	330

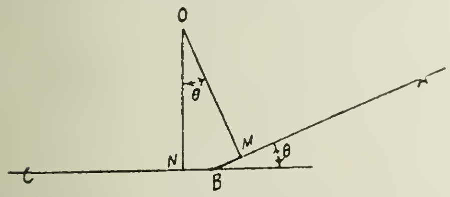
The charts and formulas give results that represent fair averages, and ensure the proper number of plies to withstand the pull upon the belt. If the number of plies indicated is only one or two, it is obvious that, though sufficiently strong for any tensile stresses, the belt would not have the necessary stiffness between the troughing idlers. The smallest number of plies that a belt of a given width should have are given below.

Width, inches.	Plies
12-16	3
18-24	4
26-30	5
32-36	6
36-48	7

A belt that is too stiff will not conform to the shape of the idlers, and will wear out rapidly at the edges. A belt having an insufficient number of plies will be so flexible that it will flatten between the idlers, and the banding may crease the belt down the centre and start the separation of the plies along this line. The weight of a properly designed belt should cause it to conform to the shape of the idlers.

Inclined Conveyors.—The charts and formulas are suitable for inclined conveyors as well as for those that are horizontal. In general, fine material, or lumps mixed with fine, can be handled on steeper angles than closely sized material. A uniformly loaded conveyor can be operated at a steeper angle than one which carries an intermittent load. Fine material has been successfully carried at an angle of 22° from the horizontal, but the limiting angle for ore should not be greater than 18°. This will effectually prevent any material from running back on the belt.

It may be necessary sometimes to place a vertical curve in a conveyor. This saves installing an additional conveyor, though, for other reasons, it may not be the most desirable solution of the problem. Care must then be taken that the belt does not rise above the idlers on the curve. This condition is most likely to occur when the part of the conveyor below the curve is loaded and that on and above the curve is empty. This danger will be avoided if conveyors, not over 30 in. wide, are installed with a curve of 250 ft. radius, and wider conveyors with a curve of 300 ft. radius. In order to determine the shortest possible radius that such a curve may have, the weights per lineal foot of the empty and loaded conveyor must be known. The curve then can be calculated from the equation of the catenary. To find the ends of a curve when the radius is known, let AB and CB be the two directions of the conveyor between which the curve is to be installed, and let $\ominus$ be the angle between these lines. If R is the radius of the curve in feet, distance BM = distance $BN = R \tan \frac{1}{2}\ominus$. Erect perpendiculars at N and M, and their intersection gives the point O, or the centre from which the curve can be drawn.



Idlers.—The spacing of troughing-idlers should bear a relation to the weight per cubic foot of the material carried. The heavier the material, the closer should be the spacing of the idlers. At the loading-points it is advisable to have the idlers placed at one-half of the usual spacing. The spacing to be recommended for troughing-idlers to convey material weighing 125 lb. per cu. ft. is given below:

Width, inches.	Spacing, feet.
12	4·5
14	4·5
16	4·5
18	4·0
20	4·0
22	4·0
24	4·0
26	3·5
28	3·5
30	3·0
32	3·0
34	3·0
36	3·0
40	3·0
44	3·0
48	3·0

Return-idlers are commonly spaced 10 ft. to 12 ft. apart. Idlers are generally cast-iron pulleys mounted on hollow shafts made of cold-drawn seamless tubing. Grease-cups on the ends of the shafts serve to force the grease through holes in the hubs of the pulleys and thus form protective rings, which effectually exclude the dirt. Steel pulleys having ball or roller bearings and using oil lubrication are economical where costs of power are high.

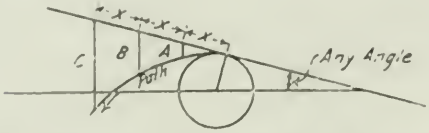
Installation and Use.—If the material is fed upon the belt in the direction of its travel and at the same speed, the wear on the rubber cover will be considerably reduced. This can be accomplished by suitably arranged chutes. If the material contain sharp lumps a grizzley or screen can be placed in the bottom of a chute close to the end. The fine material will then form a protective layer on which the lumps fall. It is not a good plan to put a chute where it supplies feed to a belt either directly over an idler or to one side of the centre of the belt. In the latter case, the belt will not run true on the idlers, but will work to one side. Chute boards and pieces of belt, used for guides, should not touch the conveyor. Guide-idlers cause rapid wear of the edges of the belt, and are not necessary if the troughing-idlers are placed at right angles to the line of travel of the belt and are carefully maintained in this position. The belt will then show no tendency to travel to one side. If the belt runs to one side, it is the third idler back that needs to be straightened, and not the one at which the side-travel appears. Idlers should be kept well greased. Whenever they run hard, or stick, both the power required by the conveyor and the wear of the belt are increased. The return part of the conveyor is covered to prevent pieces of material falling from above and getting between the belt and the return-idlers, which would injure the belt. It is advisable to examine the belt about once each week for cuts in the cover. If these holes are cleaned out with gasoline, thoroughly dried, and then plugged with good rubber cement, the life of the belt will be materially lengthened. Moisture that once gets under the rubber cover causes the plies to separate and the duck to rot. Unless all brushes and scrapers for keeping the return part of the belt clean are maintained in good condition they are of little service.

Loaded incline-belts will run backward and pile up their loads at the bottom whenever the driving-power fails, unless a check be provided. Some excellent safety-devices are on the market. A simple one consists of a large ratchet-and-pawl placed at the head of the conveyor. The pawl catches on a tooth of the ratchet and stops the conveyor as soon as the belt starts to run backward. To prevent undue strain upon it, a belt should be run just tight enough to prevent slipping, and no tighter. Care must be exercised to adjust the take-ups at the tail-pulley equally, or the belt will not run straight. Like the independent adjustment on rolls, it is not easy to move the two sides exactly the same distance.

To splice belts, cut both ends square and bring them together by means of belt-clamps. Mark the belt lightly with the points of the metallic belt-lacing or hooks, but do not drive the lacing in until the holes have been punched with an awl. Then drive in the hooks, supporting the belt on a block of soft wood. Turn the belt over, remove the block and clinch the lacing toward the joint. Before splicing, it is a good plan to coat the ends of the belt with rubber cement to keep out moisture. The following sizes of Bristol belt-lacing or their equivalent are recommended :

Ply of belt	Size of lacing, No.
3	113
4 and 5	114
6	115
7 and 8	117
9, 10, and 11	119

The trajectory of the material delivered by a conveyor is of value in designing discharge-hoppers or chutes.



The distance X in inches $= \frac{\text{speed in feet per minute}}{60}$

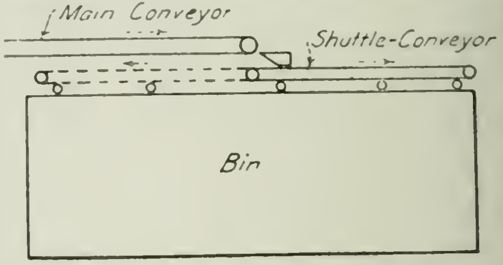
The different vertical distances from the projected line of travel of the belt to points on the path of the falling particles is shown in the accompanying table received by the Jeffrey Conveyor Company :

[illegible]	Inches.
A	0·4284
B	1·9296
C	4·3416
D	7·7184
E	12·0600
F	17·3664
G	23·6376
H	30·8736
I	39·0744
J	48·2450
K	58·3704
L	69·4556
M	81·5256
N	94·5504

The values given in the table will not hold good for material that sticks to the belt or is so light that it is easily deflected by the resistance of the air.

In selecting a conveyor belt, the tonnage carried and the length and lift of the conveyor must be considered in connection with the number of plies, width, and speed of the belt. A belt should be designed to run fully loaded to ensure the greatest economy of operation. It is evident that the same belt will not be suitable for various lengths of conveyors. One company installed an additional conveyor half the length of the one already in operation, and was surprised not to get equal wear from the belt. The more frequent bending over the pulleys, and the greater abrasion from loading, since each part of the belt came under the chute twice as often as with the long belt, caused rapid wear. Since the operating tension in the short belt was less than for the long belt a smaller number of plies, with a heavier rubber cover, was indicated for this conveyor.

Automatic trippers, though mechanically efficient, are not the most desirable means of discharging a conveyor, as they entail heavy wear on the belt. The comparatively small pulleys of the trippers cause additional bending-stresses and, because of imperfect cleaning, the material that sticks to the belt is pressed into the rubber cover by the second pulley. A shuttle-belt discharge is not open to these objections. The short belt, a little longer than one-half that of the bin, runs on a track and is moved back and forth, either mechanically or by hand. The main conveyor, extending to the middle of the bin, discharges upon the shuttle-conveyor, which can be run in either direction, thus being made to deposit its load at any desired place.



Repair, renewal, and lubrication-charges on belt-conveyors are not difficult to determine, but depreciation is a complicated problem. Reginal Trautschold, in the *Engineering Magazine*, August, 1916, states, in part, that "depreciation is due not only to wear but to constant and quite apparent continuous deterioration of the belts, whether they are in use or not, so that the depreciation charge is little affected by careful use, provided, of course, the equipment is operated a reasonable amount of the time. This deterioration is largely due to the hardening of the rubber cover and the loss of resilience, and is more apt to be accentuated by idleness than by careful use. The balance of the mechanism is not more greatly affected than other mechanical equipment, if well cared for and not abused. Ordinarily a depreciation charge of 25% on the belt and 10% on the balance of the equipment covers all reasonable wear and tear." His discussion is concerned with conveyors in manufacturing plants. Conveyors in mining and milling are subjected to such hard usage and receive so little proper care that their depreciation is undoubtedly far greater than that given above.

Apron and Pan-Conveyors.—Modern ore-crushing plants have such large capacities that great tonnages of coarse material must be handled by the conveyors. The heavy wear and the enormous strains to which they are subject make it necessary to replace belt-conveyors with those of a stronger type. For this work, apron-conveyors and pan-conveyors are now largely used. The apron-conveyor consists of a series of steel plates that overlap to form a continuous surface. The plates are carried between two heavy roller-chains, and are rigidly attached to the inner links. In the large sizes, the plates are supported on cross-bars between the links. A rail on each side carries the rollers. All the framework is of steel. Large sprockets at the ends are used for turning the conveyor. For horizontal work, the overlapping plates are but slightly curved, and the surface of the conveyor is nearly flat. Where cross-bars are used, the plates between are flat. This type is also suitable for work on slight inclinations. For steeper grades the plates are made deeper, and take the form of pans, which may be shallow or deep. For steep grades and for vertical lifts the pans are pivoted, and the conveyor becomes a bucket-elevator. The steel construction of these conveyors guarantees strength to withstand the heavy strains put upon them. The pans can be lined with renewable wooden planks or cast-iron plates, the conveyors thus being protected from wear. The slow speed of these conveyors, from 25 ft. to 100 ft. per min., 75 ft. being a good average, minimizes the wear on the mechanism. Their capacity can be made to suit any requirement; 1,500 tons per hour has been carried, and there should be no practical difficulty in handling a larger tonnage. Short conveyors of this type, from 5 ft. to 10 ft. long, are used as feeders. They are run at speeds from 10 ft. to 30ft. per min., and are placed close to the openings in the bottom of the bins. No gates are required, as the variation in the speed of the feeder regulates the flow of the ore.

Push-Conveyors.—Such a conveyor consists of a series of hinged flights attached to a moving frame or carrier. During the forward movement of the carrier, the flights project into a trough and push the material along. On the return stroke, the flights turn up and slide back over the top of the material. This type of conveyor is always of short length, and has a limited use in confined spaces. The moving frame is carried on rollers. The stroke is from 2 ft. to 4 ft. In one mill, two push-conveyors, about 20 ft. long, handled 1,000 tons of ore per day. The ore, crushed to $\frac{3}{8}$ in., was supplied to the conveyors by Challenge feeders. The steel flights were $8\frac{1}{2}$ in. wide, 18 in. long, and $\frac{1}{2}$ in. thick; the width of the trough was 22 in.; the length of stroke was 24 in.; and the flights were spaced 18 in. apart to give a 6 in. overlap. The rollers were 8 ft. apart. It was found that the smoothest operation of a conveyor was obtained when the ore was fed at a point about 5 ft. from the end.

Flight-Conveyors.—These conveyors consist either of an endless chain or of two roller-chains to which are attached, at intervals, flights or scrapers of various shapes that drag the material along a trough. Their field of operation is confined to relatively small conveyors; the material handled should be non-abrasive, and should have a low co-efficient of friction, such as grain or coal. Wear is caused by the friction of the conveyor on itself as well as by the material carried. The speed of these conveyors varies from 100 to 200 ft. per minute, and they are used on inclines up to 45° from the horizontal. The capacity depends upon the size and spacing of the flights and on the speed. Flights range in size from 4 in. to 10 in. to 10 in. by 24 in., and the spacing from 16 to 24 in. For handling coal, the horse-power required $=\dfrac{ATL+BWS}{1000}$

Where T = tons per hour.
L = length in feet.
W = weight of conveyor (chain and both flights), in pounds.
S = speed in feet per minute.

TABLE GIVING VALUE OF A AND B.

Deg. from horizontal.	A	B
0	0·343	0·910
5	0·420	0·010
10	0·500	0·010
15	0·585	0·010
20	0·660	0·009
25	0·730	0·009
30	0·790	0·009
35	0·850	0·008
40	0·900	0·008
45	0·945	0·007

CAPACITIES IN CUBIC FEET PER MINUTE, AT SPEED OF 100 FEET PER MINUTE.

Size of flights.	Spacing. 16-in.	18-in.	24-in.	Inclined, 24-in. spacing. 10°	20°	30°
4×10......	20·8	18·5	13·8	11·1	8·8	6·5
4×12......	26·3	23·4	17·5	14·8	11·1	8·3
5×12.. ...	31·9	28·3	21·3	17·5	13·8	10·2
5×15......	43·0	38·3	28·6	25·0	19·4	13·8
6×18......	...	49·3	37·0	30·5	24·9	19·4
8×18......	...	74·0	55·4	44·4	35·1	29·6
8×20......	...	...	64·5	51·8	41·0	34·5
8×24......	...	...	83·2	74·0	59·1	44·4
10×24......	...	...	106·0	92·5	74·0	55·4

Spiral Conveyors.—These consist of a steel ribbon wound in a spiral around a shaft, interrupted at intervals of 8 ft. to 10 ft. for bearings that are 2 in. to 3 in. long. In the small sizes the spiral fits close to the shaft, but in the larger sizes a narrow ribbon is attached to the shaft by studs. The depth of material is generally taken as one-third the diameter of the screw. The power required varies so greatly with the nature of the material handled that formulas give only approximate results. The weight of material per cubic foot is not always a true measure of its frictional resistance. It is customary to design these conveyors so that the pitch of the screw shall equal the diameter of the conveyor. Because of the great torsional strain involved, lengths are not made greater than 100 ft. For longer distances several conveyors are used in series. Maintenance charges are high if the material handled is gritty. It is a good plan, with such material, to make the trough large, and to let the material form its own trough. The relatively low first cost and the small space occupied are the chief advantages of this type of conveyor. Coal, coke, ashes, cement, sand, gravel, and crushed stone not over one inch in size are some of the materials that may be handled by spiral conveyors.

$$\text{Horse-power} = \frac{K \times C \times W \times L}{2.000,000}$$

Where W = weight per cubic foot.
L = length in feet.
C = capacity in cubic feet per hour.
K = 1·2 for grain.
2·5 for fine ashes, cement, etc.
4·0 for sand, coarse ashes, etc.

The following table, supplied by the Caldwell Co., gives the capacity of spiral conveyors corresponding to their diameters and the appropriate speeds:—

Size, inches.	R.p.m.	Cu. ft. per hr.
3	125	20
4	125	43
5	120	95
6	115	126
7	110	178
8	105	359
9	100	421
10	95	540
12	90	933
14	85	1200
16	80	2000

R. S. LEWIS, *Mining and Scientific Press*, 14th Sept., 1918, pp. 349-355. (H. R. A.)

Abstracts of Patent Applications.

527.18. The Mauss Continuous Centrifugal Separator, Ltd. Improvements in centrifugal separation. 29.8.18.

This application is a development of No. 521.17 by the same applicant, in which the drum is formed of separable cones capable of being opened while in action for the discharge of the solids. The improvement in the present application consists in means for maintaining the filter cloth freely permeable to the liquid.

622.18. A. H. Lynn and N. E. Rambush. Improvements in the ammonia recovery producer gas process and apparatus therefor. 11.10.18.

This application relates to improvements in the ammonia recovery gas process, consisting in condensing and separating the steam and tar from the gas simultaneously without material absorption of ammonia.

636.18 S.A. Alkali, Limited. Improvements in recovering salts from mother liquors by evaporation. 18.10.18.

The liquor is first concentrated by spraying it freely into the air and, later in the process different salts, selectively crystallizable, are recovered by stages through regulating the temperature to cause precipitation, the separation and removal of the salt crystals taking place at stated intervals in the process.

667.18. N. Y. Robertson and H. Moss. Improvements in means for controlling the flow of fluid through flexible pipes. 4.11.18.

This application refers to a device for controlling the flow of liquid through hoses consisting of a screw (or equivalently actuated) clamp by which the hose is squeezed and flattened to reduce the flow through it.

104.19. David Robert Clifton. Improved apparatus for collecting dust from rock drills working in rises. 12 2 19.

This application refers to an apparatus for collecting dust from rock drills working in rises, comprising a dust collecting chamber surrounding the drill, means for making a tight joint between the collecting chamber and the face in which said drill is working, means for supplying a spray of water to said chamber, means for removing the sludge therefrom, and means for supporting and telescopically adjusting the apparatus to its work.

146.19. Margarethe Lesser. An improved concentrator. 3.3.19.

This application describes and claims a concentrator for diamond bearing or other soil or sand, and comprises a revolving drum covered with belting or gauze with a slow turning and shaking motion under water level, whereby material under the action of specific gravity is separated into concentrates and residue.

150.19. Howard Lane Improvements in apparatus for hydrogenising oils and fats. 6.3.19.

The object of the application is to maintain a more uniform heating of the oil in treatment, and for this purpose the apparatus used consists of a pair of vertical metal cylinders one within the other with a space intervening, the whole being externally heated by a steam jacket or furnace flue. The interior vessel opens at the top and contains the agitating appliance. It also has an opening in the bottom from where the oil is drawn off and pumped up through the space between the two vessels until it flows over again into the inner vessel and so being continuously subjected to the beating again of the agitating mechanism, and at the same time maintained at an even temperature.

228.19 and 229.19. Charles Howard Smith. Furnace retorts. 31.3.19.

This application relates to a furnace retort for the partial distillation of coal, and designed for continuous operation.

It consists of a tubular metal retort, supported by masonry, in which flues act as a recuperative chamber, and are arranged with dampers to regulate the heating of any part of the retort. The retort is provided with two parallel shafts with paddles thereon which serve to mix and convey the coal towards the outlet during which time it is uniformly and progressively heated. A special claim is made for the use of "calorised" steel for the body of the retort.

472.19. F. D. Milligan. A non-porous cement. 20.6.19.

This application refers to: (1) "A compound for waterproofing and strengthening ordinary cement consisting of thoroughly slaked lime and raw linseed, or equivalent, oil, mixed together in suitable proportions, substantially as described." (2) "An improved cement formed by adding, to ordinary cement and sand, mixed with water, a proportion of a compound composed of thoroughly slaked lime mixed with raw linseed oil."

Changes of Address.

Bawden, L. B., *l/o* Knights; Langlaagte Estate & G M. Co., Ltd., P.O. Box 98, Langlaagte

Brodigan, C. B., *l/o* East Rand: Brakpan Mines, Ltd., P.O. Box 3, Brakpan

Davis, C. R., *l/o* Brakpan: Consol. Mines Selection Co., Ltd., P.O, Box 2269, Johannesburg.

Fiander, R., *l/o* Florida: New Heriot G.M. Co., P.O. Box 10, Cleveland.

Griffiths, A. P., from Active Service: 87, Warwick Road, S. Kensington, London, S.W. 5.

Margerison, S. B., *l/o* Sambas, Dutch Borneo: Totok (Noord-Celebes), Dutch East Indies.

Melvill, G., *l/o* Johannesburg: Cons. Main Reef Mines, P.O. Box 2, Maraisburg.

Noble, E., *l/o* Lebong Soelit: Lebong Tandai, Res. Benekoelen, Sumatra, Dutch East Indies.

Phillips, F. D., M.C. (late Capt.), from Active Service: Knights Deep, Ltd., P.O. Box 143, Germiston.

Pitt, C. K., M.C. (late Capt., R.E.), from Active Service: Crown Mines, Ltd., P.O. Box 102, Crown Mines.

Scrymgeour, A., *l/o* Pilgrims Rest: P. O. Graskop.

Stokes, Col., R. S. G., D.S.O., O.B.E., M.C., from Active Service: Savill Club, 107, Piccadilly, London, W.

Stidolph, N. H., from Active Service: P.O. Arcturus, Rhodesia.

Thorpe, W. E., from Active Service: Geduld Proprietary Mines, Ltd., P.O. Dersley.

THE JOURNAL

OF THE

Chemical, Metallurgical and Mining Society

OF SOUTH AFRICA.

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Vol. XX NOVEMBER 1919. No. 5.

Proceedings

AT

Ordinary General Meeting, November 15, 1919.

The Ordinary General Meeting of the Society was held in the South African School of Mines and Technology Building, Johannesburg, on Saturday, 15th November, 1919, Mr Jas. Gray (President) in the chair. There were also present:—

26 Members: Messrs. J. Chilton, G. A. Watermeyer, R. A. Cooper, J. H. Johnson, E. M. Weston, H. A. White, J. E. Thomas (Members of the Council), W. J. Abel, J. Brown, H. S. Candy, Prof. J. Cellier, J. M. Dixon, B. J. Hastings, W. H. Jane, G. Melvill, P.T. Morrisby, S. Newton, J. D. O'Hara, E. A. Osterloh, J. F. Pyles, S. H. Steels, J. Thorlund, W. E. Thorpe, J. W. Travers, H. R. S. Wilkes.

8 Associates: Messrs. R. C. Anderson, J. Boyd, O. A. Gerber, J. Gibson, J. S. Moir, H. Rusden, W. Russell, and J. A. Woodburn.

25 Visitors, and Fred Rowland (Secretary).

MINUTES.

The Minutes of the Ordinary General Meeting, held on 18th October, 1919, as recorded in the October *Journal*, were confirmed.

GENERAL BUSINESS.

NEW MEMBERS.

Messrs. J. E. Thomas and E. M. Weston having been elected as scrutineers in connection with the election of new members, the following were declared unanimously elected:—

JENKIN, EDWIN WATERS, Witwatersrand G.M. Co., Ltd., P.O. Box 2, Knights. Mine Overseer.

PULFORD, ALFRED ERNEST, Ferreira Deep, Ltd., P.O. Box 1021, Johannesburg. Dust Inspector.

WEBB, WILLMER, Simmer & Jack P.M., Ltd., P.O. Box 192, Germiston. Assistant Assayer.

WILLCOX, ALEXANDER, Witwatersrand G.M. Co., Ltd., P. O. Box 1, Knights. Mill Manager.

The Secretary: The Council has admitted the following gentlemen since the last meeting:—

As Associates:—

DAVISON, H., Morgan Crucible Co., Ltd., Battersea Works, London, S.W., Director.

GOODMAN, W., Simmer Deep, Ltd., P.O. Box 178, Germiston. Cyanider.

As Students:—

HACKER, THOMAS HINDLE STAMFORD, S.A. School of Mines and Technology, P.O. Box 1176, Johannesburg. Student.

ORTLEPP, JULIUS ADOLPH LEOPOLD, S.A. School of Mines and Technology, P.O. Box 1176, Johannesburg. Student.

SOCIETY'S ROLL OF HONOUR.

The President: You have probably observed the Roll of Honour in the inset of the last *Journal*. If you know of any additions or alterations which should be made, the Secretary would be glad to be informed of them.

AMALGAMATION WITH SPECIAL REFERENCE TO STEAMING.

The President: As you will recollect, at the meeting held last May, discussion took place on the subject of amalgamation, and Mr. Percy Cazalet suggested that the matter should be referred to the Council and that a Sub-Committee should be appointed to go into this question. Messrs. Thomas and Pearce were appointed, and their report will now be read.

REPORT OF SUB-COMMITTEE.

Messrs. S. H. Pearce and J. E. Thomas (*Past Presidents*): In view of a recent discussion as to the practice of steaming amalgamated plates—your Council requested us to investigate the matter and draw up a report as to its advisability or otherwise, and to include any other matters concerning amalgamation of general interest.

We accepted the invitation with some misgiving, as we realised that the subject would require much time. In order to save time we asked the Secretary to issue a circular to our Mill Manager members, in which a number of questions were put and from which, together with our own experience, we hoped to be able to present something of some authoritative interest. Something less than half of these were answered and to those gentlemen who co-operated in this respect we tender our hearty thanks as we used their contributions for a basis of the following remarks:—

A great diversity of opinion exists in connection with steaming, starting from those who are of opinion that by reason of danger to health it should be prohibited, down to those on the other side who equally emphatically declare it to be a necessary operation. In between we have milder expressions from those who advocate steaming as being a saving of labour, or advisable for better amalgamation and from others who suggest various methods of dispensing with the operation.

Leaving out the extremists on both sides the question resolves itself into practically a question of labour as well as health.

Under certain conditions amalgam will accumulate on plates which requires a good deal of labour to remove unless steam is used to soften the deposit. This labour will vary from scouring in various ways to the use of chisels, according to the time the deposit has had to harden.

The conditions of accumulation run in fairly definite lines, apart from voluntary accumulation for purposes of regulating the output—a matter on which we have no evidence.

Roughly speaking the involuntary accumulation may be divided into two classes—viz., that due to the mill methods employed in the first place, and that due to force of circumstances in the second, with of course an intermediate link of a combination of both.

Now the mill methods class will mean the individual system adopted by the man in charge, whereas circumstances will include the design of plant, besides any idiosyncrasy of the ore dealt with. Thus a variety of method is shown in the condition of the plate, (*i.e.*, whether hard or soft) the frequency of dressing and the grade of plate, which all have a relation to each other.

For instance a plate that has a comparatively large amount of amalgam left on it will be capable of receiving a liberal allowance of mercury when dressing, and will remain soft and in a good receptive condition longer than a comparatively bare plate under equal conditions. To preserve this quality, such plates will be scraped but lightly, and the result is an accumulation which produces a high steaming return.

The man who adopts this method will obtain a high return by amalgamation with the least labour, but will probably be accused of holding gold back, and may be reckoned a culprit as far as advocating steaming is concerned.

The next example may be taken where a similar condition of plate is arrived at with a minimum of amalgam left. This will require more frequent dressing to prevent hardening up, and hard scraping every day; probably also a thorough scouring, say every other day. This man will also have a high amalgamation return with a maximum of labour and the conscious rectitude of a humanitarian who does not advocate steaming.

A variety of the foregoing is found in those who prefer to scour less often, but make a big job of it once a month, in place of steaming.

Another variety of method is adopted by one group where a saving of mercury consumption is effected by the use of blankets, etc., and the resulting concentrate ground up in barrels, but this method deserves a special description and would form the basis of an excellent paper on its own. It is not proposed to go further into methods, because a difference of opinion exists as to whether a high extraction by amalgamation is desirable, or not, in view of the labour required and idle capital involved in laying out the plant. This doubt frequently entails a neglect of the fundamental condition of maintaining a proper plate surface and retaining the free gold there, instead of in various lodging places on its way to the cyanide plant.

Now as to circumstance, our first variety exists in the ratio of water to rock crushed. On the one hand we have a plant with launders having insufficient grade, where the water ratio is necessarily high. On the other hand we have a more modern plant with probably excess launder grade but economic in plate area. In the first case we may have a ratio of perhaps 8 to 1, and in the second as low as 2 to 1. These differing conditions will affect the grade of the plate—18% being necessary in the one case compared to 8% in the other. Apart from the overcrowding of the plate area, this extra grade causes difficulty in control of plate condition. With a bare plate there is nothing to arrest the mercury in its tendency to run off into the launder, so a choice has to be made between leaving a deposit or very frequent dressing. In any case amalgam at the top of the plate will harden more rapidly and require removal with more labour whether by steaming or by other means.

The question of shaking plates versus stationary is practically settled. There is little difference as regards recovery by amalgamation, between the two. Shaking plates require less grade and provide for a more equal distribution of the pulp—but require power and maintenance, which perhaps more than balances anything in their favour. Shaking plates also have a tendency toward accumulating amalgam similar to a plate with a steep grade.

The degree of alkalinity of the mill water also affects plate accumulations in that an excess of lime hardens the amalgam. In some mills owing to the varying acidity of the rock, the alkalinity is difficult to regulate and in these cases, a scrape made in the usual way leaves a considerable quantity behind and causes a pleasant surprise on steaming. Under such circumstances it is quite possible that a hammer and chisel may be required if the plate be not heated. On the other hand cases are not unknown where neglect to neutralise the acidity has resulted in stripped plates. The fineness of the gold amalgamated is also a minor factor: coarse gold particles do not accumulate and are easily removed, but the reverse is shown in the finer particles and thus it follows that the higher percentage amalgamated will generally be obtained from a larger proportion of such fine gold, and result in greater tendency toward accumulation. An instance of this is shown on a plant where a coarse mesh is used in the mill and the pulp passes over plates before being re-ground. The mill plates show practically no return by steaming, whereas the tube mill plates accumulate fairly heavily under similar conditions.

The foregoing does not pretend to deal with all the factors involved in the question, but are merely stated to explain why a difference of opinion on the subject should exist and also with an idea of possibly stimulating those who are interested to give further opinions.

Dealing however with the facts as they appear to us from a technical point of view ——steaming can only be considered as a labour saving device, which enables plate accumulations to be removed with the least difficulty, as otherwise, in the absence of a mechanical device to take its place, a large expenditure of labour would be incurred in most instances.

This is a matter on which a difference of opinion is to be expected and we present it with much diffidence, as opinion differs considerably even among those most interested.

However, there is no doubt, as with many other ailments, idiosyncrasy plays a very large part, and certain men suffer from some sort of indisposition after taking part in the operation. In many instances there is a probability of mercurial affection, but in at least as many others it is equally probable that the indisposition is due to over exertion and poor health. Nor would we care to assert that steaming is the chief cause of mercurial poisoning because the practice of eating meals with unwashed hands appear to us far more dangerous as a means of conveying mercury into the system. These, however, are matters on which medical men should speak, but in the absence of medical evidence to the contrary we do not consider, if proper precautions are taken, that steaming should not be continued.

The precautions advised are well known to every one, and consist in:—

Provide ample ventilation for plate houses.

Lead exhaust steam from plates to the outside of the building.

Select men for the operation who are known to be immune.

Divide the work as much as possible to prevent over-exertion.

Provide wash basins, mouth washes, etc., as recommended.

Mr. Jas. E. Thomas (*Past-President*): Owing to the force of circumstances I have been unable to take as active a part in the preparation of this report as I should have liked, so in consequence most of the work has been done by Mr. Pearce.

Considering the importance of the subject, the number of replies to the circular sent to each Battery Manager was disappointing, only about 50 per cent. being returned. If more replies had been received, it is possible that we might have been able to give a more emphatic expression of opinion on the subject, that is the expression of opinion of the majority of Battery Managers. As only 26 replies were received, we did not feel justified in saying more, but we trust that in the discussion, in which I am glad to say the members of the Reduction Workers' Association have been asked to participate, the various points will be thoroughly thrashed out.

Mr. J. M. Neill (*Member*): The request for cleanliness brought forward by the Committee is the point to which most attention should be directed. Where mercury is so continuously in use, great care should be taken, to prevent contamination of food and more particularly of tobacco. This is especially necessary where a loose supply is carried in the pocket, the risk in this case being great. Where many sources exist through which mercury may be introduced into the system daily, too much attention seems to be directed to the steaming operation which is, after all, a monthly and minor source of danger. I personally do not know of one case of mercurial poisoning which can be absolutely traced back to this cause, during the past twenty-five years.

As to the advantages or disadvantages of steaming plates, I do not know of any; all I do know is that the gold position or the financial position calls for a certain output, and this is the best way of getting it.

Turning to remarks on shaking versus stationary tables, a few figures should definitely settle the question, showing that shakers have nothing in their favour.

About 1904, when shaking tables were being advocated, I was instructed to replace two mill plates and replace them with two shaking ones. I objected, as neither practically nor theoretically could any advantage be claimed. As a compromise, however, (all the gear being available) I put two in below two mill plates, allowing the pulp to flow first over the stationary and then over the shaking plates. The result was a loss of dressing and mercury from the shakers with no gain in amalgam.

About eight years later, in face of objections raised, I had to start up a new plant with twenty-eight shaking tables.

It was an almost perfect installation from all points of view, except pulp distribution. This, however, was brought rapidly to a high degree of efficiency, and the whole plant ran as designed for a few months. Extraction by amalgamation was not sufficiently good, however, and I stopped one shaker on the 12th of February and the remainder early in March.

The following are the tabulated results:—

Date 1912	No. of Shaking Plates.	Amalgam Recovered.	Per Plate Per Day.	No. of Stationary plates.	Amalgam Recovered.	Per Plate Per Day.
Feb. 12/18	27	1,315 oz.	7·32	1	79 oz.	11·28
,, 19	23	212 ,,	9·21	5	43 ,,	8·6
,, 20	21	147 ,,	7·0	7	61 ,,	8·71
,, 21/22	20	401 ,,	10·02	8	200 ,,	12·50
,, 23/29	14	425 ,,	5·06	14	704 ,,	8·38
No run on 28th.			5 | 38·61			5 | 49·47
	Av. scrape clean amalgam 7·72			Av. scrape clean amalgam 9·89		

2·17 ozs. per plate per day under identical conditions in favour of stationary plates.

Recovery from steaming:

Shaking Plates.	Stationary
1292 ozs.	1326 ozs.

Recovery from Black Sands:

January, all shakers, 26·5% of total amalgam.

March, all stationary, 43·1% of total amalgam.

Recovery now became much better owing to direct amalgamation having risen slightly over 10%.

Mr. H. Ward (*Associate*): I am pleased to notice that an increasing interest is being taken in amalgamation and the handling of amalgam, a matter which is of vital importance to any gold mine, but especially so to the low-grade mines.

The highest possible recovery of gold by amalgamation has not yet been reached on many mines of the Witwatersrand, as the varying results will prove. Amalgamation is undoubtedly the cheapest and more reliable method of extraction.

There are mines which are only obtaining 48% by amalgamation, while others obtain as high as 75%. In my opinion the methods of working have a direct effect on these results, and the lack of efficiency has also a direct influence on residues, especially sand charges. On those mines which obtain under 60% extraction by amalgamation, I would say that there is something radically wrong..

Steaming plates is not necessary to obtain the maximum extraction, and can be entirely dispensed with.

Those mines which are in the fortunate position of being able to accumulate from 200 to 800 ozs. of amalgam on one plate, are in a happy-go-lucky state, as it is impossible to detect whether 100 ozs. of amalgam has been added or removed, during the month's run, therefore, the checking of the percentage of extraction is impossible, neither is this accumulation any credit to the efficiency displayed.

I consider that after the clean-up, 20 ozs. of amalgam is sufficient to form an effective amalgamated surface on an ordinary sized plate (9ft. 6in. × 5ft.). Any excess should be removed, and might be shown as amalgam on hand, or gold in reserve; then it becomes possible to check the grade and other necessary items. It would be quite a good investment to increase the plate area on mines where the area is small, by using some of the old discarded copper plates.

Screen samples are very unreliable and misleading, owing to the human element, and the presence of free gold, and until these factors are eliminated reliable screen samples cannot be expected.

Pulp samples may be kept fairly accurate by constant checking, and may be used as a check for the value of the sand and slime charges.

A point worthy of consideration is the adoption of a uniform method of sampling in the mills on the Witwatersrand.

Another item which requires close attention, is the factor applied for tonnage, especially sand charges, which according to various estimates varies from 21 to 25 cubic feet per ton. Such a variation does not seem possible with Rand ore.

Taking into consideration the various considerations stated above, it appears necessary to have the milling and cyanide departments under separate heads, and worked independently for checking purposes.

To obtain the maximum efficiency and extraction of the gold content of the ore it is advisable and necessary to watch the amalgamation most carefully, and also to check the residues going to the slime dam and sand dump. If this method is adopted maximum extraction would the obtained at the lowest cost.

Mr. Wm. Telford (*Visitor*): To have good amalgamation, especially on tube mill plates, it is necessary that the plates be kept in tip-top working condition and not allowed to get patchy or bare. To carry this out properly, a fair amount of amalgam must be left on the plates. The accumulation will then be much higher than if the plates are kept bare and not allowed to amalgamate properly. Thus, at the end of a month or two, there is an excess of amalgam on the plates, which has to be taken off, either by steaming or some other means.

In my milling experience during the last 21 years, I have found steaming to be the quickest, easiest and best way of getting the amalgam off the plates. It is also the most economical in that it saves time and labour. Another point in its favour is that after steaming, the plates can be brought into better condition than is the case with other processes. Owing to the heat and moisture produced by steaming, the amalgam is softer and therefore when scraped off the plate, leaves the latter smooth. A plate in this condition, when dressed, produces better amalgamation than a plate that has been cleaned up by cold scraping.

Cold scraping is a process which I have invariably found most unsatisfactory, in that it entails loss of time and requires a considerable amount of unnecessarily hard work. Owing to the lack of heat, the amalgam is so hard that even the most skilful and careful scraping leaves fine ridges of amalgam, thus causing a very uneven surface on the plate, which when dressed will not give such satisfactory amalgamation as a plate with a smooth surface. Also, in my opinion, where there is a big accumulation, cold scraping is liable to cause loss, as, during the process of scraping, particles of the dry amalgam are likely to fly off the scraper or chisel and fall to the floor where they may be trodden on and so lost.

It has been stated that steaming is prejudicial to health and ruins the teeth owing to the inhalation of mercury fumes. To refute this statement I can only say that after over twenty-one years' practical experience of scraping plates by the steaming process, my health is unimpaired and as sound as when I first started milling, and my teeth are strong and good and have not been injured in the slightest degree by the mercury fumes—both of which statements can easily be verified.

Thus I have proved by practical experience, to my own satisfaction, that of the two processes known as steaming and cold scraping respectively, the former is infinitely better, more economical and safer.

It may be that upon weakly constitutions the mercury fumes would be likely to have an injurious effect, but as far as I can see, if a man takes ordinary care of himself, and puts into practice the well-known precautions, his health should not suffer.

Mr. J. George (Secretary, S.A. Reduction Workers' Association (*Visitor*): I have had the pleasure of receiving a copy of the report in regard to amalgamation I do not want it to be imagined that I am here tonight to teach you anything about amalgation. I desire to discuss the matter from the point of view of the men's health.

Up to a few years ago, no one seemed to realise that mercury was a poison Up to the year before last, most people thought that any man who complained of mercurial poisoning was trying to 'swing the lead' on the companies. Recently, however, the Metallurgists, Heads of Departments, and the men themselves, began to realise that during the last 20 years the men who have been called "lazy" and who have been chased from pillar to post, through lack of energy, through inability to follow their employment, and inability to give satisfaction on any mine on which they worked, were suffering from a disease and were not shirking their work out of any spirit of sheer cussedness. They could not work and, unfortunately, some of the Groups have not yet realised this.

In my opinion, mercurial poisoning has undermined the health of more than 50 per cent. of mill-men I hope some of the men themselves will give their views as to how this trouble can be curtailed. I have been through most of the mill and plate-houses on the Reef. Fifty per cent. of them are a disgrace to any industry which has any consideration for its employees, as they are not fit for anything with life in it to work in. If the men speak about ventilation they are told: "Oh, it costs too much." If they attempt to make any suggestion for improvements, they are told they are either fools or rogues, or both. Now, that spirit has got to die: as a matter of fact, we have the weapon to kill it. If the Heads of Departments do not make some effort to improve the health conditions, the Industrial Diseases Act will make it so costly to injure and kill men that employers will look at the profit and loss account, and will see that it is just as well to look after the health conditions under which the men work.

The President of my Association, the Vice-President, and myself met Messrs. Pearce and Thomas with a view to discussing amalgamation and steaming. We arrived at certain conclusions. The first was with regard to the ventilation of plate-houses. There has not been enough attention paid to this matter. It does not seem to have been realised that, in addition to the fumes that come off mercury, in addition to the dampness of the average concrete floor, the most obnoxious fumes come from tube-mills, more especially from those discharging direct into the plate-house. I think that point has not received sufficient attention. The plate-house system has to be revolutionised. If a man has a wet floor to work on, if he is kept up to the elbows in water for the greater part of his shift; if the launder "cut-off" is of such a type that he cannot attend to it without getting wet and working in wet clothes for the remainder of his shift, that man is not treated as any animal would be treated, because it is quite well known that animals have a market value, and it might be necessary to sell them afterwards! As soon as it is found on some of the mines that the men are suffering a little bit, a hole is knocked in here, or a pane of glass knocked out there. That is not ventilation: it only causes more grievances for the men to complain about, such as draughts, catching cold, and so on. The system of ventilation requires to be gone into by competent men, and to be carried out on scientific lines, and in such a way that plate-houses will have an ample supply of fresh air for the men employed therein.

The subjects of wet floors, cut-offs, and defective management, are matters that require attention, and I can assure you that, for my own part, I am going to instruct my men that, when these things are in such a state that their health is endangered, they must simply leave and let the companies, or whoever may be responsible for the bad conditions, see to it themselves.

Then regarding the steaming of plates. Personally, during my 17 years on the Reef, I have looked at the operation of steaming with wonder. I have wondered where all the " brains to the square inch " are, that the steaming of plates is continued month after month, and the only substitute for it is either to start scraping two or three millimetres off the copper every month, or alternatively, to get a hundred natives in to scour the plates with canvas and sand. I think that both the methods adopted as an alternative to steaming, are equally as bad from a health point of view. In scraping hard amalgam off a plate, I have found that a considerable amount of amalgam lodged on the clothes of those doing the scraping; in fact, a very appreciable amount was carried away in that manner and, I have not the slightest doubt that quite a lot was carried away by their swallowing it, or by other means than it being stolen.

Personally, I consider it possible to perfect a mechanical appliance that will obviate the necessity for men coming into very close contact with mercury except for a very short period, certainly not to the extent that would injure their health. If some encouragement were given to men of an inventive turn of mind, it might be possible to obtain a machine to do the work that is at present being done by hand.

In the steaming of plates, there arises the question of the time spent by workers in contact with mercury fumes and about which there is a vast difference of opinion. I have found that some of the Heads have said that it is the men's own fault, and that, as soon as the steam box is taken off, they want to " jump into it " and get the job done; they want to get home. Well, that is quite natural. The point is, that the contact with the fumes can be avoided; it has been done on the Consolidated Main Reef Mine by means of an appliance in use there. Commencing work on the plate immediately the box comes off does not injure the men's health to any extent, so far as I know, and I have heard no complaints at that mine since the box was used. On the other hand, I have heard from other mines which have tried a box, or something like it (very often it does not bear very much resemblance to the original idea) that it is too big a nuisance. If there is a steam box on the same principle at another mine that will not work, the only thing I can suggest is that the man who cannot get it to work should inspect the original and see where theirs has failed. If a box works well under one set of conditions in the Consolidated Main Reef mill, there is no reason at all why it should not work equally well on any other plant. I have heard many complaints about steam boxes not working, but I think it is generally because the people who put them in imagine they can make a better box than the original one and, in making a better one, they have turned out something which was really worse.

Then with regard to cleanliness. During my experience of milling and amalgamation, it was not considered part of a mill-man's duties to keep himself clean on shift; it has not been considered necessary that he should have sufficient time to wash his hands before going to have his meals; very often he has had to eat them on shift. Consequently, after 20 or 25 years of teaching men that cleanliness of their hands or their mouths is only a secondary consideration to keeping the stamps running, or seeing there is nothing wrong with the tube-mill, that habit cannot be broken down in five minutes. There is a tendency to blame the men for not keeping their hands or their mouths clean, but those who make this statement have not realised that they themselves are responsible for building up these vicious habits and then grumbling because the men will not alter. Consequently, it will take a fairly strict set of rules, and a considerable amount of patience and time to get those rules impressed on the men in such a way that they will take adequate precautions to safeguard their health.

There is also the matter of the periodical examination of a man's teeth. It was suggested, I think, by the Rand Mutual Assurance Co. that men should come into Johannesburg and have their teeth examined periodically. This is unsatisfactory, as they would always give particular attention to their teeth before seeing a dentist, who, from their appearance would imagine that reasonable care was being taken of the teeth. The duty is on the part of the man to take reasonable precautions to avoid giving an opening for an insidious poison like mercury getting into the system. The only satisfactory method will be to examine the teeth of the men while on shift and if it is found they are endangering their health by careless or unhealthy habits in any way, they will have to be warned and, if they continue doing so and will not alter their ways so as to give them the chance of coming through in a reasonably healthy condition, they will have to be given some job that will not entail their being a danger to themselves or any one else.

Since the "Safety First" Committee has sent out placards in regard to mercurial poisoning and personal cleanliness, I have gone and inspected a number of mills, and the only provision made for washing which I have observed has been an enamel dish with a hole punched in the bottom, without any hot water laid on. Personally, after the second man had washed in it, I would refuse to use it. There is no reason why any mill-man should be asked to wash in a dish that the average native would look askance at. No more cost is involved in putting in decent hot and cold water arrangements. The idea of installing some cheap rubbishy thing as being "good enough for the men" is foolish, and the men are foolish to "stick it." As a matter of fact, the men are receiving instructions to see that the washing arrangements are adequate and, if not, to refuse to use them until proper facilities are provided.

Some unofficial experiments have been carried out during the last week or two on one of the mines by a member of our Association. He has been collecting the water used by the men on washing their hands after dressing plates. He assured me that this water contains an appreciable amount of mercury and amalgam. Consequently, the supply of suitable equipment is going to be amply repaid by the recovery of gold from this source. The elimination of mercurial poisoning will equally repay the mines for any expenditure involved. I know today many men who have been in contact with mercury are blamed for being lazy, when as a result of mercurial poisoning they are unable to do their work efficiently.

Prof. J. Cellier (*Member*): I agree in some respects with the remarks that have been made, but not entirely. It is found that mercury in the metallic state is not probably as poisonous as mercury in the cinnabar state. The cinnabar workings at Almaden, in Spain, were considered more dangerous than the workings of native ore in Idria. It is true they worked a two hours' shift on and two off, but the probable poisoning was less than it was at Almaden.

The greatest danger, to my mind, is the insanitary way workers have of taking their food when working with mercury. That can be obviated very readily. If it were insisted upon that the method adopted at De Beers, where the man on entering the works goes one way, and his lunch, etc., another, I should say it would not be at all impossible to compel men, by locking up their lunch and giving it to them only when their hands have been washed, to prevent that source of trouble. Poisoning from lead, for example, excepting where the ore is a very friable one, occurs in many instances from eating with hands which have not been washed, and even from smoking tobacco in pipes which have been filled while the hands are dirty. That the subject has not been known on the Rand, I think, is not correct. One of our old Mill Managers, Mr. Beverley Chew who was on the Robinson Deep was very badly poisoned with mercury arising through a man in the same room taking some amalgam at night and putting it into the stove; in the morning he took good care to take out the ash which, of course, contained the valuable portion of the amalgam.

Men for a long time past have been known to suffer from mercurial poisoning; some were also known to be poisoned by using cyanide to quicken the plates. I do not think we should be overscared at being poisoned by liquid mercury so long as reasonable precautions are taken.

A Visitor: With regard to the steaming of plates, I have had a few years' experience on the Reef, and the day of steaming was the only day that I was frightened of. I worked for a Mill Manager who stood over us and, as soon as the box was lifted off the plates, we had to go into the fumes and start scraping the plates. It used to take us two or three days to get over it. To-day, we are still steaming plates regularly, and I think it is about time something different was tried, to do away with it.

Mr. H. Wheeler (*Visitor*): Do you know of any experiments that have been carried out to prove that mercury is vapourised by the temperature used in steaming? Considering that the vapourising point of mercury is about 360° C. and the temperature used during steaming is about 95°, how would you account for the mercury being vapourised at that low temperature?

Mr. H. A. White (*Member of Council*): I had no intention of intervening in this discussion; but that point which has just been made is one of some importance, because there is a certain very minute amount of mercury vapour possible even at the freezing point of water. It is very considerably increased at the temperature of steam to such an extent that it may become dangerous to health. Generally speaking, this report, of course, is directed to the point as to whether it is absolutely necessary or not to steam; the intention of the report is principally to deal with this question. On that point I, of course, admit that there are differences of conditions along the Reef: "East is East, and West is West, and never the twain shall meet." Take the Princess Estate in the West and the Springs Mine in the East: one mine recovers nearly double the amount of gold by amalgamation that the other does. Some gentleman suggested to-night that this is due to defective practice in one case. As a matter of fact, I should say that where one obtains the least recovery by amalgamation the practice is probably the most perfect; much more attention is paid to it than in the mines where recovery is easy and high.

There are four principal sources of danger from mercury, and I should put the first and most important as that due to retorting, especially where it is done too hurriedly and the retort is opened before it has cooled. On this point at the last meeting Mr. Pyles made a valuable suggestion. The next and much less dangerous case, I should say, would be that of the man who has to clean the amalgam, who has to plunge his fingers into mercury daily, and has to be brought much more closely into contact with it than the man who is only scraping and dressing plates. Next comes steaming, especially where this is done in a defective manner. I have no doubt that there is a possibility of real danger there. And the final possible danger is, of course, the ordinary dressing and scraping of plates, more especially where sufficient care is not taken to remove mercury from the fingers before they are used to convey food to the mouth or to convey tobacco into a pipe. This is a source of danger which it is possible to entirely obviate; if suitable arrangements are made on the mines, I think it is quite possible we can put that source of danger into past history.

With regard to the incidence of mercurial poisoning on the mines, it is a curious thing that we have not had in this country sufficient evidence brought before us that there is any at all, except that due to retorting, where we have known accidents to happen and men to be knocked out by mercurial poisoning. Of course, we know the Rand Mutual Assurance Co instituted a large experimental inquiry in which they put a large number of men through the hands of a dentist and found a considerable proportion suffering from their teeth; but found it rather difficult to state that that was due to mercurial poisoning. They were inclined to believe it was; but we have not obtained that strict scientific evidence on the point that we should have, and I do not know how we are going to get it, because defective teeth, as we know, are simply a mark of civilisation. In America they have about 70,000 dentists employed, and not a very large proportion of the people in America ever see mercury, except sealed up in a thermometer or barometer. In order to obtain that evidence, I should suggest that the Miners' Phthisis Bureau should put through an examination a thousand of the miners who come up periodically, and compare the figures so derived with those of the reduction men. If they find that the incidence of teeth trouble and mouth trouble is very much less, in that case we should have some valuable evidence, which at present is rather lacking. I always believe in getting facts where possible.

With regard to steaming at the present time, before we have these mechanical appliances that are promised and which may eventuate later on. Now, if there is a sufficient body of opinion amongst the workers that it is dangerous, that is sufficient for us to act upon. You see, we are not bound to wait for evidence on that point. If there is a pronounced feeling amongst our men in the mills—if they actually feel that steaming is dangerous, I should say that that notion in itself, at the present stage, is sufficient to condemn it. We all know if there is a clash between the interests of the work and the interests of the worker in these times, which goes to the wall. If the work is going to slightly suffer because we are going to abandon steaming, then if the health of the worker can probably be improved, I think that in itself is sufficient to enable us to say that steaming is going to die out on the Rand, it is going to die right out. We shall have some old-timers who are going to grudge a little extra work, but, if they are going to do that at the expense of health, it should not be permitted. All those who are in the habit of steaming should try every other method first and persist in the best until they have found it is almost as good as steaming at the worst.

Mr. W. H. Jane *(Member)*: A little while after I started work on the mines, many years ago, I was steaming plates; I was very young and very enthusiastic, and wanted to show of what stuff I was made, and I got into the steaming of plates with a vengeance. It was not the Battery Manager's fault; I did it myself, as many more have done since. Well, at four o'clock in the morning they had to send for the doctor; I was completely laid out with mercury fumes. I suppose I was fortunate in getting that lesson, which I have not the slightest doubt has saved my health to a very considerable extent since.

With regard to one point raised by Mr. George. One of the greatest difficulties I have had for a number of years is to prevent the men using their hand to smooth the amalgam at the top of the plate. I do not like the practice; I never did. It is absolutely unnecessary. Time after time when dressing plates, men will be found who, instead of using the spoke brushes, will use their hands to smooth the amalgam. I have stopped it hundreds of times, but the practice is still persisted in. That practice is a relic of the "good old times" when men were trained in that way.

Another point that has occurred to me whilst listening to the discussion on hard amalgam. Amalgamation is a physical process, it is not a chemical process. The gold is caught by amalgamation because it has a higher specific gravity than mercury, therefore all the amalgam on the plate was once soft, and got hard as it went down the plate. Within very small limits it could have been recovered before becoming hard.

I should like to confirm the opinion expressed by Mr. George that a considerable loss, taken over the whole of the reduction plants of the Reef, occurs in the process of scraping plates when steaming. Despite the care taken, amalgam is lost, and though slight on each plant, it amounts to a considerable sum when taken collectively.

Probably I shall endeavour, if time permits, to make a further contribution regarding this matter, after fully considering the report and the discussion.

Prof. J. Cellier: If I may be allowed to add to my previous remarks, there is one point that we must not forget. In Wales there are numbers of miners who are not in very good condition from following a comparatively good mining occupation —a healthy one, I mean. It was found that these men never changed when they came up from underground. They probably got wet, went into the train and drank tea that was very strongly brewed, and that probably caused more disease than anything inherent to the occupation. If the men do not wash before they eat and wash when they go home, it would pay the companies to supply them with suits which they can work in; it will save mercury, health, and insurance.

Mr. J. E. Thomas *(Past-President)*: With reference to the effect of the discharge from the tube-mills into the plate-house, it might be useful, before any reply is made to the discussion, to investigate the health conditions of those masons, who get into the tube-mills to re-line them. Those men, certainly, come more into contact with the fumes than men working in the plate-house.

Mr. E. M. Weston *(Member of Council)*: I think the Secretary of the Reduction Workers' Association has done a good service in coming here and presenting the views of the workers directly. The discussion on many papers which come before this society would be more interesting if that practice was carried out still more, and we had an opportunity of hearing the views of the operators on the various processes on the mines and elsewhere. We usually have expressions of opinions from the financial and technical standpoint, but we do not always get the human point of view, and I think it would add to the value and usefulness of our discussions if similar expressions of opinion on the lines given us by Mr. George were available more frequently.

Although I am not a metallurgist, I have stated before that I consider amalgamation is an out of date, heathenish process, which could be quite well dispensed with on the Rand. Having no scientific facts or arguments to bring forward in support of this revolutionary statement, my suggestions are not approved by our leading metallurgists. Somthing has been done already in this connection at the New Goch Mine, and amalgamation has been greatly reduced with much benefit. I must say that the discussion to-night has strengthened my views very considerably. I hope the Heads of the Metallurgical Departments of the various Groups will give the subject their serious consideration and eliminate amalgamation altogether.

Mr. G. Melvill (*Member*): I have been using Mr. Walker's steaming box at the Consolidated Main Reef for the last five months, and must say there are absolutely no fumes during the steaming operation. The steam should be shut off a few minutes before removing the cover so as to allow any fumes that remain in the box to be dissipated, and the men should not start scraping immediately the cover is removed. If this steaming box were adopted on all mines and the above precautions taken, I am sure the danger of mercurial poisoning will be reduced to a minimum as far as steaming is concerned.

The greatest source of danger is during retorting. The men are always in too great a hurry to get away, and very often the retort is drawn before all the mercury is off. Before opening the retort, the fire should be drawn, and when the gold is taken out, it should be left in a well-ventilated spot in the smelting room, and not touched until it has cooled down a little.

The practice of eating meals and filling pipes with dirty hands should be discouraged. There are some shiftmen who would never think of washing their hands or brushing their teeth if they could help it; and there are others again who are most particular.

I believe in keeping a fair amount of amalgam on the plates, and steaming each plate every four or five months.

Mr. W. E. Thorpe (*Member*): Speaking as an assayer—purely an amateur with regard to amalgamation—is there any necessity for close steaming, if the plates are well bedded with silver amalgam?

I think where mercurial poisoning is chiefly caused is in smelting owing to improper packing of doors, etc.. A great deal of wet lose asbestos is used, and a lot of fumes escape when this dries out and crumbles on the retort getting hot.

Damp sheet asbestos gives a very much better joint and avoids a lot of leakage.

The President: I would like to remark, with regard to Mr. Weston's suggestion about the interest which has been occasioned this evening by the presence of the members of the Reduction Workers' Association that they are probably well aware we should be only too pleased to welcome them at any time and to have their contributions to discussions. The particulars regarding membership can be obtained from the Secretary.

This paper on amalgamation will be open for discussion at subsequent meetings of the Society. We do not meet again until February, but in the meantime, any contributions to discussion sent in will be inserted in the *Journal*.

SOME POSSIBLE CAUSES OF DISCREPANCIES BETWEEN MINE & BUYERS' WEIGHTS OF GOLD BARS.

By Harry R. S. Wilkes (Member).

Differences between the mine weights of gold bars and those of the same bars, recorded by the buyers at home, before melting, often occur; and further differences, after melting, generally are recorded. This is of course well known as is also the fact that these differences are apparently all in favour of the buyers.

The account sales usually give three records of weights, viz.: —

1. Mine weight.
2. London weight before melting.
3. London weight after melting.

It is with the differences between these that the writer proposes to deal.

There are two general methods in use on the Rand for pouring gold;

Method A. Pouring without slag, after skimming.
,, B. Pouring under a slag cover.

The former is most suitably employed in dealing with gold of high fineness, the latter when melting gold containing much base metal.

The correct condition for pouring gold, is that it be at as low a temperature as is compatible with slow pouring. The estimation of such a temperature is a matter of considerable judgment, and may be almost said to enter the province of the expert, at any rate the ability is only to be acquired by long and constant practice. It often happens that this condition does not obtain, because of the fear of having the metal freeze before pouring is completed.

It is customary with both the methods (A and B.) after the metal has set, and while still hot, to quench it in water, or weak acid; in water to remove the slag (method B.) and in weak acid to clean the surface before scrubbing.

The centre of the bar is the last to set, and after setting a further contraction takes place until the bar is comparatively cool. Hence a cavity is formed in the centre due to the rigidity of the rapidly cooled sides. As this cavity forms, a partial vacuum is set up, which draws into it through the centre of the top of the bar, *i.e.*, the line of least resistance, a filling; in case of method A., of water; and of method B., of slag, with sometimes a little water. Usually the aperture connecting with the cavity is a small one, either a fine crack or a pin hole.

Conditions under Method A.—In this case the cavity is filled with water or weak acid, and differences between local and home weights, before melting, often occur. These vary considerably, since in some bars the apertures are so small that evaporation on the voyage to England is incomplete, and also some bars are subjected to more or less heat to dry the surface before weighing. If the bars poured by method A. are thoroughly dried, no differences between local and "before melting" London weights should occur. When they do, they are due to weighing and clerical errors. Owing to the lengthy war period, during which account sales have not been received, precise information of differences are not available.

For many years its has been the writer's practice, when the bar has been cleaned, to place it on the hot cover of the smelting furnace for about twenty minutes. Within fifteen minutes if the cover is hot enough the contained water is expelled with some force, in jets of water or steam through the small apertures of entrance, and only when steam ceases to issue from these holes is the bar considered dry for weighing.

On two occasions, it was possible, with cold bars, by injecting air with a blow pipe, to release the contained water, which amounted in one case to 10 cc. and in the other to 15 cc. These quantities will be referred to later.

Conditions under Method B.—For some time after the bar has set and while it is still contracting the slag cover remains in a molten state, and is thus easily drawn into the cavity. If the bar is quenched in water to remove the slag, while still very hot a little water is often drawn in as well, and completes the filling of the cavity. Of 230 consecutive bars poured by this method 39 only showed a loss on reaching London, and the average difference between local and "before melting," London weights was only 0·037 ozs., or 0·74 dwts. This loss, the writer suggests was due to evaporation of the water filling, during the voyage, *i.e.*, the water which entered the cavity after the slag had been removed from the bar. The slag which had already partly filled the cavity of course remained unchanged during transport.

Weights "after melting" are of course considerably less than those before melting, and it is sometimes assumed that this loss is solely due to the refining by oxidation during the remelt; doubtless there is some such loss, but that it accounts for the total difference is open to serious question. For example:—

Of 22 consecutive bars poured by method B. the average difference between the fineness estimated by assay at the Mine, and that estimated by the buyers, was 0·07 milliemes, the buyer's assay being the higher. This difference on the 22 bars amounted to 1·5 ozs. in favour of the sellers.

The fine gold allowed for by the buyers was however 16·5 ozs. less than the Mine estimation owing to the loss of weight in remelting, nearly all of which may be fairly assumed to have been due to encased slag.

Dip samples being taken in London, for assay, the increased value of 0·07 milliemes in the London assays most likely represented the amount due to refining during the the remelt, which in the case of the 22 bars under consideration amounted to a total loss of weight of 1·5 ozs. In support of this may be presented the fact that the weight of slag sufficient to displace 10 cc. of water is approximately 0·76 ozs., and as above stated it was found possible to release 10 and 15 cc. from 2 bars respectively.

The weights taken for assay by the buyers, and the pot scrapings, are, or should be included in the final weight of the bar at home.

The writer is indebted to Mr. E. O. Durrant for reminding him that a discrepancy must occur between home weights and those of Johannesburg due to the difference in density of the air displaced by the brass weights used. Brass approximately occupies weight for weight twice as much space as gold, and Mr. E. J. Laschinger has estimated the difference in density of this displaced air when weighing a bar of 1,000 ozs. to be equivalent to 7½ grains which amount should be added to the home weight. (*This Journal*, October, 1904.) The addition of this discrepancy would have brought the average deficiency on the 22 bars noted, to approximately 0·77 ozs.

From the foregoing the writer is led to the conclusion that only an apparent discrepancy exists between the values of the gold estimated here and those received from the buyers.

Mr. L. Monckton has designed a very neat electrical apparatus for drying gold bars.

Mr. J. Hayward Johnson (*Member of Council*): I beg to move a very hearty vote of thanks to Mr. Wilkes for his very interesting paper. This subject was brought up many years ago* in this society, and a special Committee was formed to investigate the matter of both weights and assays: and I think it would be interesting if some of the members of that old Committee were to come forward and give their opinions on the points brought forward. I believe we have present here this evening Mr. Brown Chief Chemist of Messrs. Johnson, Matthey & Co., and Mr. Kahan from the Australian Mint; they might give us some very interesting facts on this subject.

The President: Mr. Brown, of Messrs. Johnson, Matthey & Co., London, is with us this evening, and I am sure he will be able to give us the London point of view in the matter.

Mr. H. J. Brown (*Visitor*): I do not know that I can add much to what the paper has said it is certainly very complete in its way, and the reasons which are put forward are those which have been known to us for many years. I did not know but that South Africa also was cognisant of the fact, thereby making it unnecessary that this paper should be read here tonight.

The London weight differences described here—I take it, you say "London" because London has been the chief buyer of your gold for many years past. During the war—which period Mr Wilkes has omitted, advisedly because of Account Sales not having been received—some of the bullion also went to the Colonies, and I have had an opportunity of examining these figures, the differences in which appear somewhat similar to those which have obtained in the past in London. Consequently, it is a universal difference, not an artificial one, and as Mr. Wilkes says, it is an "apparent" difference only. I might just say, shortly, that the statement with regard to the water sucked in through the holes is evidenced by the fact that when we open boxes from the bank at our premises, the sawdust packing where the cavity exists is perfectly wet and has to be scraped away, proving the presence of water.

With regard to the loss in melting. Of course, there is a certain loss by volatilisation of base metals—base bars especially. I was very much struck by the lack of uniformity in weights of high grade bars from a certain mine, and after my assistants had had returned from the war, I had time to make some investigations. Some of the bars were melted without a cover, when a film of slag was distinctly observable. Others were melted in the usual way under a cover of carbon, and an examination of the carbon cover after pouring revealed the presence of adherent slag. Therefore, I can only confirm what the paper has said in this regard.

I perhaps might criticise the statement that the correct condition for pouring gold is at a low temperature. Now this seems to require confirmation or modification. I daresay there are a good many smelters here

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*See this Society's Proceedings Vol. II. : 1897—99, pp. 1, 46, 791, and this *Journal* Vol. V. : 1904—05, pp. 138, 217, 224, 253, 313, 341; Vol. VI. : 1905—06, pp. 19, 36, 49, 161, 192, 248, 346.

to-night, and they will perhaps let me know later on whether my contention, according to their experience, is correct or not. I rather think, in base bars especially, that vast differences would be found by pouring the bar at a particularly low temperature. The question of segregation comes in, and if the sample is taken, as it was in this country during the war, by simply drilling from one end to the other, either top or bottom, or both, then you are going to get wide differences. I have seen differences as wide as 10 milliemes between two different drillings on the same bar when cast cold.

The method in London, and I dare say it is the same in other places, when that kind of bar is melted at a fairly good temperature, not a high one, but certainly not a low one, is to thoroughly stir the metal. I may mention here that our regulation in stirring the most base bars is 100 times, and I often hear a junior while passing the head melter when he is stirring the bar (and he alone does it) say: "What tune are you playing, Bill?" "Oh, the Old Hundredth." So you see, great care is taken with these base bars When it is stirred a hundred times, the metal is thoroughly mixed, and the most dependable assay is therefore obtained from a dip sample. Corners are also taken off as a check. With this particular method of stirring and pouring at a fairly good temperature, we find that the differences are very slight indeed between the chip and the dip, although the dip is taken as the actual assay for purchasing purposes.

With regard to the statement in the paper:—

> "The weights taken for assay by the buyers, and the pot scrapings, are, or should be, included in the final weight of the bar at home"—

Well, I think there is an element of doubt expressed in that sentence and I would suggest, when these Notes are incorporated in your *Journal*, that the words "or should be" be eliminated, because they are most distinctly wrong. If a bar after melting loses only a few points of an ounce, and when I tell you that the dips and chips weigh a couple of ounces, you can quite imagine those pieces are weighed with the bar. There are no perquisites whatsoever in the Buyer's Refinery—we should certainly have had you metallurgists down on us like a ton of hot bricks, were it so.

This opens up the question of pot scrapings, and I might just say here, in passing, that all the recoverable losses are weighed and accounted for with the bar.

I am very much obliged to you for the kind invitation you and your Council have extended to me to be present this evening. It has been a most interesting session. In my experience of metallurgy, I have come across every subject that has been discussed at this meeting, including Industrial Diseases

I sat at a Conference of Managers at the Home Office some years ago, on the question of the incidence of lead poisoning, and I think the same precautions as are embodied in the Act in England would apply to this question. If they were carried out properly, I feel sure the incidence of mercurial poisoning would not be so very great.

If there is any question I can answer later, I shall be very pleased to do so, if it is within my ability.

Mr. H. R. S. Wilkes (*Member*): I am very glad to have been able to elicit the information that these sample weights and pot scrapings are weighed in with the bar My reason for putting in that "or should be" was, in talking over the matter with friends and fellow-practitioners, considerable doubt has been expressed on that point. I shall be pleased if that phrase can be eliminated. I had no definite information before.

Mr. H. J. Brown: You have my strict assurance, sir.

Mr. R. R. Kahan (*Visitor*): I have not had any experience of melting South African bullion, but when melting bullion produced in Australia there is a loss in melting similar to that described in the paper. My experience of melting fine gold or an alloy of fine gold and silver is that there is no loss due to melting, but when base metals are alloyed with the gold melting losses occur. I am not familiar with the method of pouring ordinary bullion without slag after skimming, and should like to know something about the method. Does it consist of making the slag thick with bone ash, etc., before skimming?

When melting coppery bullion, say bullion containing 7 or more per cent of copper, I think that the best method is to use charcoal instead of the ordinary fluxes, and to sprinkle fine charcoal in the ingot just as it sets in the mould. This prevents a certain amount of oxidation and produces a better ingot Generally for other alloys the ordinary flux, *i.e.*, a mixture of borax and soda nitre, is the most suitable.

I agree with Mr. Brown, and do not advocate pouring gold when it is very cold. It is necesary to attain a moderate temperature so that a homogeneous mass is obtained before taking the dip samples and pouring the bullion immediately after sampling. Have the melters of gold bullion noticed that the temperature of the mould has a considerable influence on the appearance of the ingot after cooling? If the temperature of the mould is too high, a porous ingot is obtained, and consequently it absorbs more water than it otherwise would.

Quenching the ingot either in weak acid or water should not be carried too far. The ingot should be removed from the weak acid or water while it is hot, say so hot that it cannot be handled with comfort; by this means any water enclosed in cavaties is evaporated.

It would have added to the interest of the figures in the paper if the fineness and base content of the 22 bars melted had been stated, because the melting loss is connected with the base metal contents of the bullion. Assuming that 22 bars were a thousand ounces, the loss of 16 ounces is equal to about 0·07 or 0·08% of the weight of the bars. From my experience of melting bullion of an average composition, about 800 to 810 gold, 120 to 130 silver and the remainder base, a loss of 0·07 to 0·08% does ocur. Of course, when melting bullion containing less base, a smaller loss in melting occurs. Zinc produces high melting losses, frequently when melting this class of bullion heavy fumes leave the surface of the metal while it is being stirred, and these fumes even condense on the edges of the mould and pouring table while the bullion is being poured.

Mr. Wilkes is to be thanked for the information given in the paper. I was particularly interested in the last paragraph stating that there is a difference between Johannesburg and London weights due to the difference in the density of the atmosphere at the two places. A visitor to Johannesburg has to become accustomed to change some of the standards of comparison used at sea level, for example, I am accustomed to think of an atmospheric pressure as 15 lbs. per square inch, but realise that it is considerably less here.

"A SAFETY FIRST METHOD FOR THE ESTIMATION OF CO_2 IN MINE AIR."

By H. R. S. Wilkes (*Member*).

(*Printed in Journal, May, 1919.*)

REPLY TO DISCUSSION.

Mr. H. R. S. Wilkes (*Member*): There exists very little reason for a reply to this paper since there has been no discussion on it; my remarks will, therefore, be brief.

My thanks are due to Mr. Gibson who having had practical experience with the apparatus, has spoken with authority, and has entirely understood the suitability of the method for the work it was designed to do.

His remarks closely represent the opinions of all those practical men with whom I have actually used the apparatus below ground.

When there have been differences between the results obtained by the standard method, and those of that under consideration, they have occurred in the writer's absence and have been estimated by gentlemen to whom he has had no opportunity of demonstrating the method of working.

My thanks are also due to Mr. Wartenweiler for his words of appreciation.

Dr. Moir has nothing to say about the method itself; silence in such a quarter may surely be taken as the highest praise. The "only useful thing" he finds to say on the matter is a personal one. It has been my privilege since last meeting to read Dr. Moir's paper on a similar subject, and I was greatly interested to note the many points of difference between Dr. Moir's process and the "Safety First" method.

Such apology as is due to Dr. Moir is gladly proffered, as well as to any other writers who may have been unknowingly neglected. There are no references in Dr. Moir's paper to other writers, thus it would appear that the doctor and the humble practitioner have been, unintentionally and unconsciously, of course, "*Arcades Ambo*"

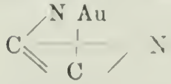
GOLD—ZINC—CYANIDE.

By W. R. Feldtmann (*Past President*).

(*Printed in Journal, August, 1919*).

DISCUSSION.

Dr. J. Moir (*Past President*): Mr. Feldtmann's discovery of two crystalline forms of aurous zinc cyanide is very interesting, but it is not very likely, although not impossible, that one is aurous zincocyanide and the other zinc aurocyanide. The constitutional formula of $K\,Au\,Cy_2$ is probably tetrahedral and symmetrical, *viz.*:—



whence there should be no difference between gold-zinc and zinc-gold cyanides. This formula is adopted so as to have no grouping analogous to free cyanide, $K.C \vdots N$ or $K.N = C$, as these complex cyanides are comparatively stable.

BWANA M'KUBWA COPPER MINE—NORTHERN RHODESIA.

By E. M. Weston (*Member of Council*).

(*Printed in Journal, September, 1919*).

DISCUSSION.

Mr. E. M. Weston: I would like to make the following correction in my paper (Sept., 1919, Journal, page 30), for "but is probably a porphyry" read the following:—"This rock owing to the fineness of the silica grains and the presence of a large proportion of well crystallized felspar, has the appearance under the glass of a porphyry. Prof. R. B. Young, however, kindly cut a slide which shows the rock to be a felspathic quartzite."

HANGING WALL SUPPORT ON THE FAR EAST RAND.

By L. W. Macer (*Associate*).

(*Printed in Journal, October, 1919*).

DISCUSSION.

Mr. J. A. Woodburn (*Associate*): There is one point I should like to bring out in connection with Mr. Macer's paper, and that is with reference to coal mining practice in the flat workings of the East Rand. In the early part of his paper he says: "An opinion has been widely held that the panacea for hanging wall trouble in the flat mines lay in the 'adoption of colliery practice,' but to the writer, and to others who have come to the East Rand with coal mining experience, it has become apparent that to deal with a colliery roof is an entirely different proposition from the support of an East Rand hanging wall."

Then later he says: "A method comparatively recently introduced, known as the 'panel system,' makes use of pillars regularly placed and subsequently removed. The system in conjunction with footwall crosscutting is illustrated in *Fig. 2*. It approximates to the pillar and stall method in colliery work, the stalls being 70 to 120 ft. wide with pillars of 30 ft. It is undoubtedly the best method of controlling the roof weight in a stope where the face advances slowly, and it effectually obviates the dangerous condition mentioned in the earlier portion of this paper."

So that after all, he has still adopted a modification of colliery practice as the best so far experienced.

What I wish to bring out is that colliery practice is not confined to one and only one method, but where one is dealing with a flat seam or bed, then colliery practice is more applicable than metal mining practice, which has been evolved in the working of reefs or veins or irregular masses of ore deposits, and these are entirely distinct and different from beds or seams of ore.

Single and double stall methods of colliery work have been long practised in particular cases, and in many coal mines, experience has shown the roof to behave very similar to the sketch *B* as shown on page 53. Sketch *A* is an ideal roof which is no doubt frequently, but not always, found in practice in coal mining. I take it Mr. Macer does not recommend that permanent pillars should be left, but that the pillars mentioned are merely temporary ones which are removed at an early date, as the working advances.

I quite agree with him that the slower rate of advance of the face, compared with a coal face, is an additional cause of the trouble in the hanging wall.

He mentions that cracks develop parallel with the face, and as in coal mining, should this be the case and the roof break up in parallel slabs which tend to come down close to the face, an improvement is made by altering the line of the face, so that the cracks found in the roof are at an angle of 30 to 45 degrees to the line of the face.

Whether the cracks in the hanging wall of the East Rand mines are entirely due to pressure on the face, or whether these are inherent in the strata, and only become apparent as the result of the pressure would be established if it were found that the cracks were always parallel to the line of the face, irrespective of the direction in which the face is being worked. With regard to cogs or pigsties, the binding of these with old ropes is no doubt a good practice, as these should be made to resist bursting pressure more than vertical pressure. Too strong vertical posts at the corners is not to be recommended, as they tend to delay the settlement of the hanging wall on the packs, and to create a tendency for the roof to break by the pressure being confined to one spot, rather than spread over the whole pack. Strong vertical posts may be required close to the face, but these should be withdrawn as the pigsties approach, and the corner posts of all pigsties should be put up so as to yield to vertical pressure, and yet be able to bind the corners together to prevent bursting, until settlement has taken place. It would have been very helpful to the better realisation of the problem if the distance between pigsties were given, as probably more of these are required, and even the spaces between built in with good pack walls.

Mr. E. M. Weston (*Member of Council*): The author has introduced an interesting subject. I do not think it is generally realised how much conditions vary, both as regards roof pressure and also in the way the hanging wall breaks. I remember in the earlier days of the Brakpan Mines, when an immense fall occurred owing to recklessly stoping a large area of rich ore, eight or 10 feet thick near the shaft, noticing that there was no sign of widespread original pressure and collapse, such as one sees in the mines of the Central Rand today. Only 10 to 15 feet of roof had fallen, and above it the ground stood, so that it was possible to climb about over the fall. In this case pillars would have supported the roof. On the other hand, in certain portions of the State Mines, near No. 4 Shaft, some of the ground was so heavy that an attempt to drive through it was abandoned, as the only safe method seemed to be to take a wide drive, put pigsties continuously along each side, and place heavy caps on these. In other mines, such as Springs, the roof often is crumbly and breaks slant. This is perhaps the worst and most difficult hanging wall to deal with as the conditions tend to large losses in ore and fines due to small roof falls. Then again the condition of heads over the reef makes a great difference. If the leaders in the quartzite over the leader are rich enough to send to the mill, then filling for packs or pigsties has to be drawn from the unsatisfactory soft shale of the footwalls. If, however, as in many places, especially at Modder B, a section of the hanging wall quartzite about two feet thick breaks down easily and breaks up into pieces splendidly suited for building good packs of masonry, the problem is simplified. When the reef is eight to 12 feet thick or more, as it is in certain areas and all rich enough to mill, the only proper solution of the problem appears to lie in some pillar and stall and method with subsequent robbing of pillars as it is practically impossible to cheaply supply enough material to fill any kind of support used. Where Leyner drills are used, the ore of a stall 70 feet wide can be cheaply stoped by keeping the face in a zig-zag shape, using the machine first to drill three or four holes in one face and turning it round to do the same in the other. The supports suggested by the author seem admirable ones, provided the pressure does not come too heavily on the uprights before the bulk of the pigsty takes the weight. I see no reason why the method used in the Central Rand of packing ore in the stope to form supports could not be combined with the pillar and stall method on the East Rand, and thus very largely do away with timber supports. The whole matter of roof supports only forms a part of the problem as to what is the best lay-out underground to extract the ore in the cheapest manner. I have always been of the opinion that all tramming drives should, as far as possible, be kept in the footwall, their lay-out in straight lengths of 500 or 1,000 ft. being guided by pilot drives on the reef itself. If this is done the collapse of any wall is of small importance as the block can easily be reclaimed by raises. If the main travelling ways of a mine are secure, subsidences have few terrors. I do not agree with Mr. Chilton that the mines of the East Rand will ever be troubled with regional roof pressure to anything like the extent experienced on the Central Rand.

A GENERAL REVIEW OF THE ECONOMIC RESULTS ATTENDING THE GOLD AND BASE METAL MINING IN THE PRETORIA INSPECTORATE DURING THE PERIOD 1904 TO 1914.

By Tudor G. Trevor (*Member*).

(*Printed in Journal, October, 1919*).

DISCUSSION.

Mr. H. E. King (*Visitor*): At a recent meeting of the Executive of the South African National Union, certain suggestions by Mr. Howard, of Lydenburg, were submitted, in connection with the working of auriferous ground in country districts. The proposals, which are intended to apply to all ground outside the Rand area not held under mining title, and have reference to the Lydenburg district in particular, as that is known to be mineralised over a very large area, are as follows:—

1.—Throw entire area open to pegging, protecting farming interests.

2.—Commute owner's mining right for royalty on amount of gold won.

3.—Value of work done per annum to be the condition of tenure.

4.—No licenses to be charged .

5.—Area peggable by each prospector to be limited to reasonable working dimensions to be settled by "Diggers' Courts," under charge of Mining Commissioners.

In the Lydenburg district the reefs are numerous and persistent, but are mineralised irregularly in a manner quite different to those on the Rand. These numerous chutes, patches or channels of payable ore are of varied dimensions, and favour the establishment of many small mines, sometimes wide apart, sometimes grouped, with an occasional large mine at wide intervals. Such conditions would be adapted to individual and private enterprise.

No central organisation, governmental or private, could satisfactorily supervise the hundreds of small propositions that might be in operation in this area, but whilst the nature of the case makes State mining impracticable and undesirable, State co-operation would be of value.

But there are many limitations and disabilities under which diggers and prospectors labour on these as on other outside fields. The first limitation is that the majority of farms on this belt (80 miles × 20) are not proclaimed as public gold fields. The next is that before a farm is proclaimed the owner may peg 20% of it in mynpacht, besides other rights, and in that much broken up country, cut up with kloofs in every direction, it is generally easy to make the 20% cover most of the hillside faces where the reefs can be best attacked, and also secure the most favourable conditions for water. Very little worth having would be thus left for the public. The effect of this priority in pegging is to give the land owner, usually a company, a practical monopoly of which he makes little use. Such owners should be compelled to develop. South African financiers want properties which they can float for large sums; five and ten stamp propositions, and alluvial deposits are not much use for company flotations.

The remedy for this state of things is to throw open on the conditions mentioned above, all ground not held under mining title.

If these terms were granted, it is believed there would be a rapid expansion of the industry, including a considerable production of alluvial gold. To-day, no intelligent digger is interested in the proclamation of farms. Such proclamations, preceded by the pegging of mynpachten, simply mean that the legitimate miner is for ever excluded from the most valuable parts of any gold field.

The paramount necessity to-day is the removal of restrictions, and help for diggers in developing the district.

Something has been argued about the respect due to vested interests in the form of owner's mining rights. It is not suggested to confiscate those rights (to peg mynpachten and receive half the revenue drawn from the public in the licenses), but to change this for a royalty or amount of gold or other mineral won. The "rights" are of small value to a company presently seeking large mining units, and they are worse than useless to a farmer, for if he pegs his mynpachten, he is simply saddled with a yearly rental. The change would, therefore, benefit both land owners and the public. Revenue would be obtained from production instead of by taxation of effort, and the condition of tenure would also prevent the locking up of gold-bearing ground for speculative purposes.

The granting of such relief would be followed by rapid expansion. A wide field for State co-operation would be offered in the following directions:—

1.—Roads would be needed to certain sections, which would be at once taken up under the conditions named.

2.—Central Customs Mills would be necessary to help groups of small mines, and in some cases ground or aerial trams to connect with the mine. It often happens that a section of good ore is opened, but the development to justify the expenditure of several thousand pounds on plant is beyond the financial resources of the digger. The "customs" mill would enable him to convert his ore into cash almost as soon as it was mined, carry on when the yield fell below costs, and help him to follow the reef through an unpayable zone in the hope of again striking good ore. This method of State co-operation would yield direct and indirect returns to the State out of all proportion to the moderate amount of capital engaged. At present the digger exhausts his resources in exploratory work and developing his property, and is exhausted of capital by the time he requires a reduction plant. The charges for hauling and milling should be framed on a scale to cover the usual redemption of capital and interest.

There are sections of country where valuable ore bodies may be expected to occur at 200 or 300 feet deep. These sections could be tested by a small diamond drill, the cost of such test, plus 50%, to be a first charge on the property. If the test failed, the money would be lost, but the knowledge gained would prevent further waste. A limited amount of money should be placed on the Annual Estimates for exploratory drilling. There is State aid in other countries on these lines, and they may be considered a form of State prospecting which is a legitimate part of the governmental research.

The Lydenburg fields have great natural and artificial advantages in the way of climate, soil, water, and two lines of railway penetrating to the gold field. If the area was thrown open to public exploitation, it would become a very active and progressive field, and be of value in solving the problem of unemployment. Phthisis patients have found it out, and benefited by the climate, and in open air methods of mining some have met with success as prospectors. Although State co-operation would be of some use, even in the present onerous and prohibitive conditions under which the diggers struggle, that is regarded as a small matter compared with the right to peg, and work gold wherever found outside the limits of present mining title, and with due respect for all other interests.

No demands could be more moderate and reasonable than the prospectors. They simply ask for permission to work, due regard being paid to all private and public rights which do not interfere with the development of the Union of South Africa.

Note re Licenses.—A license must be charged, to establish a right for the particular digger, otherwise one digger would always be infringing on another digger's right—the amount could be made smaller, but something would have to be charged to pay for proper supervision of diggers' courts and other places for settling disputes, etc.

Mr. H. A. White (*Member of Council*): The fact that in this Pretoria district alone the Government derived a direct revenue averaging £80,000 per annum for the last ten years from its mineral resources, which at the same time provided the means for great agricultural development, forms the basis for the plea to be put forward for some form of State endowment of prospecting, for the provision of a topographical survey of the Union and the extension of the geological survey.

It is a sign of the times, due to excessive swing of the democratic pendulum, that governments are being called upon to perform many functions that can be better executed by private enterprise. This leads to the sterilisation of individual effort to which the expansion of our race is largely due. On the other hand, there are directions in which government activities can be usefully employed, even in the opinion of the most conservative. If, for example, as at the present time, the country apparently possesses a surplus of white labour in consequence of economic derangement caused by imperative war needs, it is only by Government effort that this labour can be best utilized to the advantage of the country. When a new country like ours is in such a position, it can only be because vitally necessary capital works are being unduly neglected. Railways and roads are not being made fast enough, irrigation schemes require speeding up, and public enterprise generally needs stimulation. The new form of Government loan now freely advertised will rapidly provide the necessary capital, especially if the certificates are made legal tender at their accrued value, as they certainly should be.

There is, however, a further direction in which Government may be urged to move to the advantage of the country, for the benefit of the returned soldier, who has a first call on its resources, and to enable the man thrown out of employment by phthisis to earn a living in the open air. I refer to the encouragement of prospecting, which has of recent years been almost neglected in this country.

In the Government Mining Engineer's report for 1917 the Inspector of Mines for Natal says that practically no prospecting is going on, and that mineral deposits should not be neglected in the way that is being done at the present. In the report for 1918, the same gentleman returns to this point, and says: "If competent prospectors were employed, I am sure that success would attend their efforts."

The Mining Bureau of Vancouver has recommended to the Canadian Minister of Mines that returned soldiers with a knowledge of prospecting should be employed under the district engineers by means of a fund provided for that purpose, the Government to share in the profit of discoveries made under that policy. The matter is also being considered in the United States and in Australia, while Major C. S. Goldman, well known in this country, who is now settling in British Columbia, advocates the training of prospectors by large mining companies, and the exploration of the country by these men in organised parties. There can be no real doubt of the benefits to be derived, and I would like formally to move the following resolution, to be submitted to the Minister of Mines:—

> "That the Chemical, Metallurgical and Mining Society of South Africa earnestly requests the Government to provide funds for the training and maintenance of suitable returned soldiers and phthisis men as prospectors, under the direction of the Government Mining Engineer."

Mr. E. M. Weston (*Member of Council*): I think the mining community owe Mr. Trevor a debt of thanks for bringing forward such a paper as this, and I would suggest that a specially bound and illuminated edition of the pamphlet be presented to each member of Parliament and the Government, so that those very wise people who sit in high places may have some idea driven into their heads of what the country owes to the miner. His treatment has been little short of scandalous. I have just visited the growing tin field on Oliphant's River, and owing to the state of the road, our car did five miles to the gallon of petrol, and the united engineering abilities of the party were necessary to rescue it from the depths of a vlei. The huge area of this district referred to has still great attractions and possibilities for enterprise, but until the law is amended on the lines of granting free entry for prospecting with certain rights on all farms without the objectionable option money system, and until the Government give substantial future relief in the matter of claim licences, the prospector is unduly hampered and the speculator discouraged. I know of an instance where an enterprising and honest attempt has been made to disclose a tin mine. Certain success has been met with, yet there is no legal method of compelling the owners to grant sufficient time to prove if the deposit really warrants the exorbitant price agreed upon for the farm. The owners may thus reap all the benefit of another's pluck and enterprise. This is not right or fair.

I think Mr. Trevor's theory of values is quite correct. As the one who first introduced the subject of gold values in relation to prices before this society nearly ten years ago, I think I may be pardoned if I refer to that paper.

It is rather amusing to look back on the amazement with which my critics greeted my prophecy that there was a probability that in the future the gold production of the world might be in the hands of a trust. Also that gold might reach a price of £7 per oz. I was apparently looked upon as some lunatic, but I think that I can claim that the positions I took up have all been justified by the course of events since then. I hope the society will admit it has at least one prophet in its ranks! But seriously, I think that the opening up of the numerous small and promising gold propositions in South Africa should be encouraged in every way. I am sure a small development company, controlled and managed by mining men, and where shares were owned by the workers of the mines, could be run with profit to all and with benefit to the State In this connection, Mr. Woodburn is to be congratulated in being so closely associated with the opening up of a new gold field.

I have very much pleasure in seconding the resolution moved by Mr. White. I think that the scheme suggested, carried out on sound lines, would do very much to solve some of the troubles that are threatening the country, largely due to unemployment of returned soldiers. It does seem strange that prospecting has been neglected. I have recently been visiting the areas of Namaqualand I am speaking also, I think, with the approval of the Government Geologist who inspected it—which has been shamefully neglected in the matter of prospecting If properly instructed prospectors were afforded an opportunity to prospect certain areas, I have no doubt but that valuable results would accrue. As an example, I may refer to an interesting discovery of gold which has been made at Kalgoorlie. Kalgoorlie is one of those Gold Fields which has almost reached its zenith. The Government gave the matter consideration and the Assistant Government Geologist directed a scientifically arranged scheme of prospecting into the Hampton Plains country, some 20 miles to the south of Kalgoorlie. He assisted to a great extent in guiding the prospectors to where they might find the most favourable auriferous country: and instructed them in the system of loaming and showed how valuable deposits obscured by heavy overburden might be discovered if proper methods were employed. The result of that has been, judging by the latest cable advice, that a new and most valuable Gold Field has already been discovered.

There are tremendously large areas in Africa in which one is quite certain that valuable deposits are obscured by overburden. I have also been up into that immense country called Northern Rhodesia, and there is no doubt that it is one of the most highly mineralised parts of Africa. The hindrance to prospecting there is the heavy overburden; but there is no doubt that scientific prospecting carried on there would be very richly rewarded; in fact, it has been so in many instances. With these practical examples before us, I have no hesitation in asking the society to vote unanimously in support of this motion.

The President: If there is no further discussion on the resolution proposed by Mr. White, I will put it to the meeting:—

RESOLVED:

> "That the Chemical, Metallurgical and Mining Society of South Africa earnestly request the Government that a fund be provided for the training and maintenance of suitable returned soldiers and phthisis men as prospectors under the direction of the Government Mining Engineer."

The resolution was declared carried unanimously.

The meeting then terminated.

Notices and Abstracts of Articles and Papers.

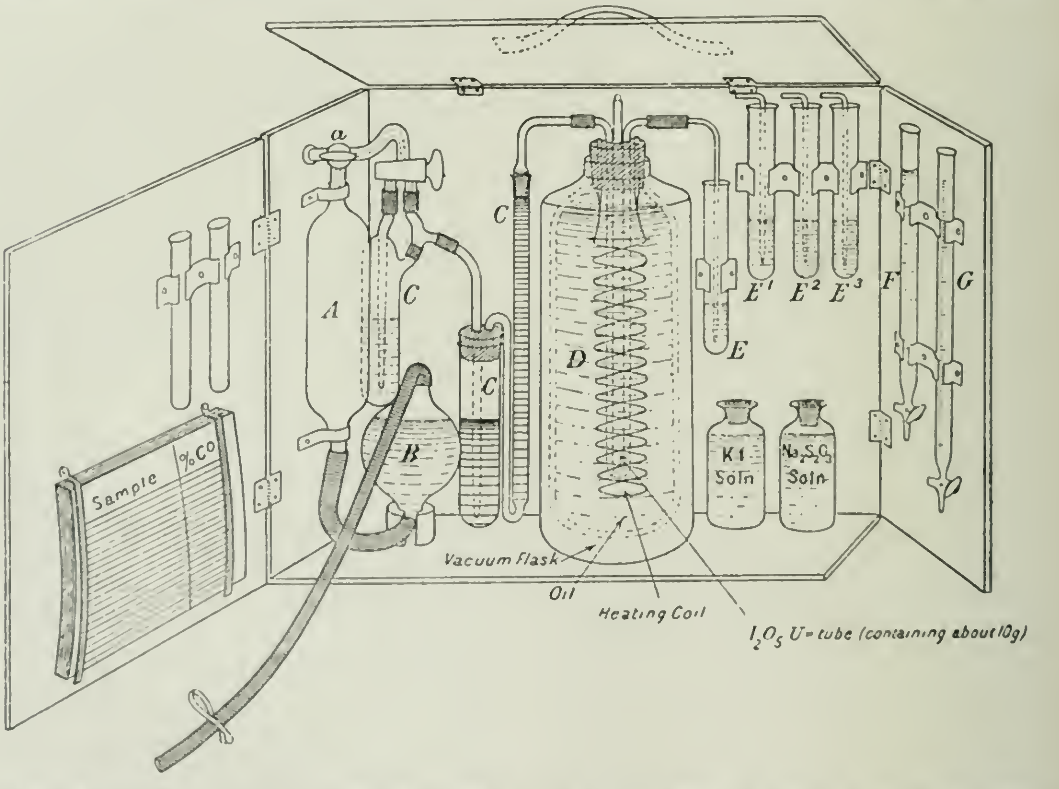
CHEMISTRY.

THE ACCURATE DETERMINATION OF CARBON MONOXIDE IN GAS MIXTURES.—"Methods of estimation based on the reaction $5CO + I_2O_5 = 5CO_2 + I_2$ are capable of giving exceedingly accurate results if certain precautions are observed. The author has adopted two methods for use in the routine estimation of this gas according to whether (*a*) the carbon monoxide content exceeds 0·2%, and an accuracy of 0·02% is sufficient, or (*b*) the carbon monoxide content is about, or less than, 0·2% and a greater degree of accuracy than 0·02% is required.

For the analysis of samples under (*a*), an improved form of apparatus previously described by the author in collaboration with Mr. T. F. Winmill is used (Trans. Chem. Soc., 1914, 105, 1996; Jrnl. Soc. Chem. Ind. 1914, 914). The main improvement consists in replacing the beaker of water, used for heating purposes, by a small tin bath. The necessity for cooling the iodine pentoxide U-tube to approximately the laboratory temperature before the final reading is taken is thus obviated, since all burette readings are taken with the U-tube at the constant temperature of the steam bath, and thus a considerable saving of time is effected when carrying out a number of analyses.

The steam bath also holds a second small U-tube containing palladinised asbestos (5%), connected on the one side to a three-way stop-cock and thence to the burette, etc., and on the other to the ordinary form of Haldane combustion pipette.

Very often, and especially in analytical work connected with coal mines, it is necessary to estimate very much smaller quantities of carbon monoxide than those dealt with in the apparatus referred to, and to obtain results accurate to less than 0·01%. An apparatus made in a portable form has therefore been devised for this purpose. It can be made in either of two forms—the one for use underground in safety-lamp pits and the other for use in naked-light pits or other places. The method employed is substantially the same in each case. A known volume of the air to be analysed is passed over iodine pentoxide heated to a temperature between 90° and 150° C. (after removal of all gases which interfere with the reaction), whereby the carbon monoxide is oxidised to dioxide and a corresponding amount of iodine liberated. The iodine is absorbed in a solution of potassium or sodium iodide (10%) and titrated with a standard solution of sodium thiosulphate, using starch solution as indicator. The analysis can be completed in about five minutes and an accuracy of 0·005% obtained without much difficulty. The apparatus was specially required for the determination of very small quantities of carbon monoxide in mine air, since 0·2% in air is highly dangerous, and even working in an atmosphere containing 0·2% for a period of eight hours would appear to have unpleasant after effects.



I. *Apparatus for use in safety pits.*—The difficulty met with has been to keep the iodine pentoxide at the requisite temperature. This has now been overcome by using a good thermos, or other vacuum, flask, filled with oil of high boiling and flash point. The latter is heated to about 150° C. before commencing a series of tests, and the loss of heat has been found to be only such as to reduce the temperature of the contents of the flask to 90° C. after seven hours, thus leaving ample time for a great number of tests underground. To avoid the trouble of taking the apparatus to pieces in order to heat the oil, an electrical method of raising the temperature has been devised, by means of which the contents of the vacuum flask can be raised to 150° C. in the course of about five minutes and the apparatus is then ready for use.

The apparatus illustrated consists essentially of the following, contained in a portable wooden case with hinged front, side and top:—A. Gas sampling vessel, capacity 100 c.c. (or other known volume), fitted with three-way stop-cock, *a*. B. Reservoir connected to A (and containing about 100 c.c. of water) by means of which the sample is taken into A and passed through the apparatus during the subsequent analytical process. The reservoir is fixed and the passage of the gas sample brought about by blowing through the indiarubber tube fitted with a pinch clip. C. Set of absorption tubes for purifying and drying the gas sample; the first contains a strong solution of bromine in potassium bromide solution, the second saturated caustic soda solution, and the other solid caustic soda, calcium chloride, and finally phosphorus pentoxide. The bromine vessel is fitted with a small glass valve, so that when the apparatus is standing practically no bromine vapour diffuses over into the strong caustic soda solution. Since mine air contains practically no trace of unsaturated hydrocarbons under ordinary conditions, it has been found useful to have a second three-way tap so that the gases can either be passed directly through the caustic soda solution if unsaturated compounds (which interfere with the action of iodine pentoxide on carbon monoxide) are known to be absent—or if the contrary is the case by turning the tap the other way the sample may be made to bubble in a fine stream through the bromine solution, and then passed on through the concentrated soda solution. D. A vacuum flask, containing oil and fitted with a bung holding the U-tube containing about 10 grms. of iodine pentoxide, a thermometer, and two narrow tubes containing a small quantity of mercury, into the bottom of which are sealed copper leads connected to the heater. The latter is made of nichrome or other high resistance wire. It has a resistance of approximately 220 ohms when required for use where the ordinary lighting circuit is 220 volts. In order to raise the oil to the necessary temperature, two leads from the lighting circuit are placed in the mercury cups and the current passed until the requisite temperature is obtained. E. Delivery tube connected at one end, by an indiarubber connection, to the iodine pentoxide tube, the other end being so drawn out and dipping into the potassium iodide solution in a test tube that the gas passing through the apparatus comes out of E in a series of very small bubbles. Complete absorption of the iodine is thus ensured. E^1, E^2, etc. Spare test tubes containing 10% potassium (or sodium) iodide solution. F. Ungraduated burette containing starch solution (approximately 1%). G. 5 or 10 cc. burette graduated in 0·1 cc. containing sodium thiosulphate of such strength that each 0·1 cc. (*i.e.* 2 drops) of solution is equivalent to 0·01% of carbon monoxide when using 100 c.c. of sample.

To carry out an analysis, the tap, *a*, is turned to connect to outside atmosphere, and by opening the pinch clip and blowing through the tubing connected to B, A is filled to the top with water from B. The pressure in B is then released and the water allowed to flow back from A to B until the 100 cc. mark is reached (the quantity of water in A and B is just such that the levels are the same at the 100 cc. mark).

The tap is then turned to connect to the purifiers, C, and the 100 cc. sample forced rapidly through the apparatus—the tube, E, being not yet connected. This preliminary "washing out" process fills the purifying tubes, etc., with the sample to be analysed. A second 100 cc. sample is then taken in as before, the tube E (dipping into the potassium iodide, solution in the test tube), is connected to the iodine pentoxide tube and the sample then passed through the apparatus at such a speed as to complete the passage in approximately two minutes. The tap, *a*, is then turned to the horizontal position, thus shutting off A from both air and purifier.

E is then disconnected and the test tube containing potassium iodide solution removed from the spring clip; a little of the solution is drawn up into E by suction in order to rinse out the inside of the tube, and a few drops of starch solution are added—the characteristic bluish-violet colour of starch iodide being produced if any appreciable quantity of carbon monoxide has been present in the sample. Standard thiosulphate solution is then added, drop by drop, until the blue coloration completely disappears.

When more than 0·3% of carbon monoxide is present in the sample under investigation, a portion of the iodine liberated may condense in the upper part of the iodine pentoxide tube or in the delivery tube, E. To obtain accurate results in such a case, 100 cc. of the sample may be passed through the apparatus and the iodine liberated absorbed (without the preliminary "washing out" of the purifiers, etc.), followed by the passage of 200 cc. of fresh air—or air of small known carbon monoxide content. Any condensed iodine will then be volatilised completely and carried through into the potassium iodide absorption tube. The amount of carbon monoxide present in the air used for "washing out" the sample is then deducted from the actual amount found. The accuracy of any determination can be increased by passing several 100 cc. lots through the apparatus without changing the tube, E, or the potassium iodide solution.

Before commencing any series of tests, *i.e.*, just after heating the contents of the vacuum flask to 150° C., it is advisable to do a blank test on 200 cc. of fresh air. The potassium iodide solution should give no appreciable colour on the addition of a couple of drops of starch solution.

A number of spare test tubes with delivery tubes are fitted by means of spring clips into the case. The same solution and tube can, however, be used over and over again provided the decolorisation has been very carefully effected in each case.

The complete apparatus in case weighs about six pounds.

The following results give an idea of the accuracy obtainable with careful working of the apparatus :—

Carbon monoxide and air mixture.

Vol. of Sample.	Temp. of I_2O_5	Time of passage of sample.	%CO by titration.	Actual quantity CO present.
	°C	mins.		%
1 200 c.c.	83	2½	0·056	0·061
2 ,,	84	5	0·058	0·061
3 ,,	115	8	0·061	0·061
4 ,,	120	3	0·060	0·061
5 ,,	136	4½	0·061	0·061
6 ,,	137	4½	0·060	0·061
7 ,,	161	5	0·066	0·061
8 ,,	165	8	0·070	0·061
9 ,,	170	4	0·067	0·061
10 100 c.c *	96	2	0·270	0·277

*Washed out with 300 cc. of air and corrected for the CO content of the latter.

Similar results have been obtained with other mixtures containing carbon monoxide. The apparatus has also been employed very successfully underground. The results given above show that the best range of temperature for carrying out the analysis is 90°—150° C.

The thiosulphate solution can be standardised to refer to samples measured at 15° C. or any other temperature. Any variation in temperature can then be allowed for—for example, if the thiosulphate solution is standardised for use at 15° C. and the apparatus is being employed in an atmosphere at 20° C., the correction to be added to the titration result will equal 1·5% of the latter. Correction should also be made for pressure when this differs considerably from normal."—J. Ivor Graham.—*Journ. Soc. Chem. Ind.*, Jan. 31, 1919, 10T—14T. (J.A.W.)

Lead in Tin Plate.—"About 0·5 gm. of the metal is heated with 10 cc. of concentrated sulphuric acid until metallic particles are no longer visible; after cooling, 20 cc. of 5% ammonium oxalate is added and the mixture again heated in order to dissolve remaining traces of iron. Alcohol is then added, the lead sulphate collected, washed with dilute alcohol, then dissolved in 15 cc of hot 50% sodium acetate solution, and bromine water added, drop by drop, to the warm solution until a slight excess is present. After 5 minutes, the precipitated lead peroxide is collected, washed with hot water, rinsed into a beaker with cold saturated sodium acetate solution, and treated with 20 cc. of 5% potassium iodide solution and 10 drops of acetic acid; the lead peroxide decomposes rapidly, and the liberated iodine is titrated with thiosulphate solution. Each cc. of $N/10$ thiosulphate solution is equivalent to 0·01036 gm. Pb. The lead sulphate obtained by the treatment with sulphuric acid contains tin, and if weighed directly the results obtained are much too high."—J. Deininger, *Z. Unters. Nahr. Genussm.*, 1918, *36*, 66-67.—*Journal of the Society of Chemical Industry*, Dec. 16, 1918, p. 736a. (A. W.)

Electrolytic Precipitation of Zinc.—"The following conditions must be observed for the best results in the electrolytic deposition of zinc from solutions of the sulphate. (1) The solution must be absolutely clear and free from colloids. (2) The iron content should be low, and arsenic, antimony, copper, cobalt, nickel, and in general metals more electro-positive than zinc must be absent. (3) The solution, particularly in tanks containing large amounts of acid, should be cold. The zinc is deposited in a semi-passive form; but when it begins to dissolve solution cannot be stopped in any simple way. (4) The zinc concentration should be as high as possible (6—7%) and no attempt should be made to electrolyse solutions containing less than 1·5—2·0% of zinc. (5) With the ordinary cascade system the optimum current density is 25—30 ampères per sq. foot."—D. McIntosh. *Trans. Roy. Soc. Canada*, 1917—18, [iii], *11*, 113—119.—*Journ. Soc. Chem. Ind.*, Jan. 31, 1919, p. 12a. (J. A. W.)

METALLURGY.

Notes on Cyaniding.—"*Arsenic.*—There is a wide spread belief among cyanide men that the mere presence of arsenic in an ore stigmatises it at once as being refractory. Nowhere is this belief more prevalent than in Rhodesia. I have yet to learn that arsenic influences the extraction one way or the other when the cyanide process is used. For a long period I cyanided raw a concentrate composed mainly of mispickel, and obtained 95% recovery of the gold contents. I have frequently successfully treated by raw methods ores containing smaller quantities of arsenical minerals. I think the arsenic bogey has its origin in the frequent association of arsenic with pyrrhotite, antimony, and graphite. The first two minerals cause premature precipitation of the gold almost as fast as it goes into solution if they are present in sufficient quantity. Graphite varies in its behaviour according to its age, and the occluded hydrocarbons present. If arsenic is associated with the above minerals, trouble is sure to arise, and the arsenic generally gets all the blame. Semi-oxidised ores of arsenic are difficult to treat, but the trouble is usually due to acid ferrous salts rather than the arsenic. Arsenic sometimes causes trouble with amalgamation, and sometimes does not; but one scarcely uses the term refractory in connection with a constituent of an ore that merely causes trouble with amalgamation. Roasted arsenical ores do not as a rule yield such a good extraction as roasted pyrite ores with arsenic absent. One is usually lucky if one gets an 87% recovery from a roasted ore rich in arsenic. But the ore should not be roasted unless other troublesome elements are present, or unless the arsenic is wanted.

Antimony.—I have never been able to cyanide successfully by ordinary raw treatment an ore containing appreciable quantities of antimony. Nor have I seen any record of anyone else doing it. The problem has provided the chemical crank with an excuse for spending very large sums of money, and many promising processes have been built up in the laboratory, only to fail in practice. I have had certain experience with antimonial ores during the last few years, and the development of the present method of treatment, which yields a high percentage recovery, is of interest. The determination of the exact antimony content of the ores being treated has never been attempted owing to the lack of competent chemists. But from the fact that a considerable tonnage of pure stibnite can be picked from the ore during a few months, it is apparent that the antimony is present in appreciable quantity. Years ago when antimony was first detected in these ores its presence was immediately followed by a plentiful supply of alkaline sulphide in the cyanide solution. The extraction became so bad that the cyanide process was discontinued while detailed experimental work was carried out. Experiments carried out in those days indicated that a roasting furnace was necessary. Roasting antimonial ores is not a satisfactory process. A certain proportion of the gold seems to get alloyed with the easily melted stibnite; and nothing on earth will dissolve the gold in this alloy. While the high-grade concentrate and sand was being roasted, experiments indicated that the gold in the slime could be dissolved after long-continued oxidation in the air. A process was eventually evolved which involved the building of four or five slime dams. After one dam was full, it was allowed to drain and oxidise for a few months. The surfaces were then ploughed, scraped off, and cyanided. This process was repeated till the dam was finished. Then the next was treated in rotation in a similar manner. Following on this discovery it was found that the gold in the sand and concentrate could be recovered in a similar manner. The oxidation of the antimonial concentrate was very obvious to the eye, the colour gradually changing from a dark grey to a light yellow. When first produced all sliming in cyanide solution would only yield about 50% extraction. But after six weeks' oxidation with an occasional turning, over 93% extraction could be obtained by similar treatment. This method of treatment was then adopted right through the plants. Concentration was abandoned, as the mineral oxidised just as well in the sand and slime dumps as it did if separated and treated separately. Of late years experimental work has indicated that the ores could be treated direct from the mill, providing no lime was used in the circuit. This has been tried out in practice with satisfactory results as far as the sand is concerned. Owing to the solubility of antimony in alkaline cyanide, it is not possible to add lime to the mills and achieve good results. Consequently the abraded iron which mainly goes with the slime is reduced to the ferrous state and independently of the antimony effectually upsets the extraction from this product when treated direct without lime. In connection with the sand, however, it is found that the residue rises proportionately to the lime used, and the best results are obtained when no lime is used at all. About ½ lb. of lead nitrate is used per ton of ore, and the sand is slimed in an acid solution. The consumption of cyanide is naturally heavy, but the good extraction counterbalances losses in this direction.

The sudden appearance of metallurgical troubles, and the gradual evolution of methods to overcome these troubles is very interesting. I wonder whether the phenomena described might not occur under favourable conditions in other parts of the world. When a consulting metallurgist experiments on a refractory antimonial ore he can scarcely be expected to try out a scheme demanding several months' atmospheric oxidation. Consequently it is not likely that the first method described has been often tried out. Metallurgists are so wedded to the standard alkaline cyanide solution of the text-books that with experimental work they are not likely often to try an acid solution for a change. Gitsham used an acid solution in his process, but went on to the other extreme, using sulphuric acid to generate HCN, and regenerating his cyanide with lime afterwards. The failure to treat an antimonial ore before, and the successful treatment after oxidation, or before oxidation in the absence of lime, is of interest, and it is possible that the principle can be applied to the treatment of other antimonial ores both in Rhodesia and other countries. I recall my experience when experimenting on the large antimonial lodes of the Gwalia Consolidated Gold Mines in West Australia, and I regret that experiments on these lines were not carried out there."—W. B. BLYTH, *Queensland Gov. Min. Journal*, July 15, 1919, p. 300. (H. A. W.)

ZIRCONIUM STEEL.—" '*Engineering and Industrial Management*' contains a reference to the important part zirconium promises to play in the future metallurgy of the steel industry. There have been reports about the striking properties it bestows on steel, but nothing very definite had been published up to the time the armistice was signed. The chief difficulty had evidently been, and still is, the production of a uniform ferro-zirconium. It is evident that until raw materials are obtainable from which a dependable ferro-zirconium can be made, definite scientific progress is impossible.

Information now comes from France, meagre though it is, regarding some of the properties of zirconium steel. An article in Le Genie Civil reveals the striking properties of french steel containing nickel and zirconium. A steel of medium carbon content and the usual nickel three per cent., but only 0.34% of zirconium, not only possesses a very high tensile strength and an elastic ratio of over 85%, but also in toughness surpasses any other steel hitherto made. The statement is made that this steel, with a thickness of only 10 m.m., had afforded a better resistance to German bullets than the nickel-molybdenum or the chromium steels of greater thickness. The steel also has a Brinell hardness of 470—a high value.

Attention should be called, however, to the silicon manganese contents of the steel in question. These are high—1·5% and 1% respectively. The what extent these two elements may be credited with bestowing the unusual properties we are not told. The value of both manganese and silicon in steel is already appreciated. It is a high manganese content alone that has made possible the production of cast steel chain in this country having properties superior to those of any chain heretofore made. It is probable, however, that, in the same manner that vanadium bestows upon steel antifatigue properties, zirconium increases to a remarkable degree the toughness."—*Industrial Australian and Mining Standard* from "Engineering and Industrial Management," 21st August, 1919, p. 342. (C. J. G.)

SLIME TREATMENT ON CORNISH FRAMES.—"Mr. S. J. Truscott's paper published by the *Institution of Mining and Metallurgy*, by the request of the Tin and Tungsten Research Committee, contains the following résumé on frame working:—

Nature of Surface.—The plane surface, and particularly that of wood, does better work than the fluted surface on ordinary slime. The finely fluted surface is the better of the two on reground material.

Bed-length.—On ordinary slime a bed 3 ft. in length does twice as good work as one of 6 ft. The longer bed requires a greater rush to get rid of the gangue in the time allowed. On reground material even a shorter length of say, 2 ft. could be used with advantage.

Inclination.—The inclination should be such that during feed, about 80 per cent. of the gangue is removed.

Washing.—Washing to remove some of the little remaining gangue is effective, raising the value of the concentrate at an insignificant price of recovery. It is, on the other hand, of diminished service when a large proportion of the material has settled during the feed.

Rate of Feed.—With ordinary slime the best rate of feed appears to be about 4½ tons per day for an 18 ft. concave round frame and 15 cwt. per day for a 6 ft. flat frame. At a rate much greater than this too great a drop in recovery would occur, while at a lower rate there would be an unnecessary drop in capacity. With reground material the above-mentioned rate may be increased substantially and, perhaps, doubled.

Consistency of Feed.—The liquid-solid ratio of feed is best kept at about 10 :1. No greater ratio is required for effective concentration, while, within limits, a smaller ratio has the advantage of permitting a heavier rate of feed without causing a rush.

Duration of Feed.—The duration of feed, that is the time taken to load a frame, is best kept about 4 minutes; the flat frame should accordingly be flushed at that interval, while a round frame should make a revolution in about 4½ minutes. A shorter duration would not give the gangue particles time to travel down the bed.

Regularity of Feed. To the above factors must be added the regularity in feed. Such regularity can only be given by pyramidal or conical settlers with pointed bottom discharge."—*The Engineering Review*, 15th March, 1919, p. 256.—(J. J. R. S.)

AUTOMATIC COPPER-COATING OF STEEL.—"Plating sheets with copper has received great attention from practical and scientific men, but, aside from the deposit secured by immersion of iron in copper salts, by electro-plating, or by welding together thin sheets of iron and copper, these efforts have so far met with no success. At the works of the Metals Plating Company at Elizabeth, N.J., the plating of iron sheets with copper by a new process is now in operation. The plating metal is applied to the sheet in the form of a liquid mixture, presently to be described, by means of rolls, such as inking rolls. The sheet, after being coated with the mixture, is automatically carried forward and deposited on a link-belt conveyor, which carries it through a furnace maintained at a temperature well above that of molten copper. The basic principle involved in this method lies in the application of the plating metal to the sheet while this is cold and then melting the metal in place on the sheet under conditions which are favourable to the formation of the plating.

While being carried through the furnace, all volatile constituents of the paint upon the sheets are distilled, the copper oxide in it is reduced to metal, and the copper unites with the iron to form a firmly adhering coating. The atmosphere of the furnace is kept reducing in order to preserve the coating as far as possible from oxidation. The carrier delivers the sheets to flattening rolls, which pass them on to another carrier operating at lower temperature, upon which they cool. Articles of other shapes than sheets, such as wire and tubes, can likewise be copper-plated on the same principle and by the use of similar continuous automatic apparatus. Other metals as well as copper, such as tin, lead, and alloys of different metals, can also be used as the plating metal."—J. W. RICHARDS, *Iron and Coal Trades Review,* April 11th, 1919, p. 437. (J. A. W.)

THE USE OF X-RAYS IN METALLURGY.—"In a contribution bearing this title, M. E. Schneider (President of the Iron and Steel Institute) said that the apparatus used at the Creusot Works was the standard type of plant manufactured by Messrs. H. Pilon, who were the licensees for the Coolidge Tube in France. The following was a summary of the results obtained since the plant was installed of the researches into segregation and blow-holes and influence of aluminium on cast steel. Steel plates (railway fishplates 25 mm. thick) were cast in sand moulds without any special precaution being taken. The photographs showed a number of white spots, each of which represented a blow-hole. But at the moment of casting the plates, 37·5 grammes of aluminium for each kilogramme of steel was added in the case of one, and 75 grammes per 100 kilogrammes weight of steel in the case of the other. The two photographs showed a diminution in the number and size of the blow-holes when the quantity of aluminium added on casting was increased, and also showed clearly the action of this metal in deoxidising the molten steel. By radiographing test pieces containing increasing quantities of aluminium it should thus be possible to determine, for a given casting, the minimum quantity of aluminium to be added to eliminate central blow-holes.

In stating his conclusions, the author said that in the present state of our knowledge of X-rays and their production, the application of radiometallography enabled visual examination to be made of the ordinary steels, provided their thickness did not exceed 40 to 45 mm. This limiting thickness was reduced when the steel contained at least one constituent of higher atomic weight."—M. E. SCHNEIDER, *Iron and Coal Trades Review*, May 2, 1919, p. 540. (J. A. W.)

MINING.

MINE-DUST SAMPLING.—"Tests are being conducted at the Pittsburgh station of the Bureau of Mines on the sugar-tube method of collecting dust samples from the air of metal mines, a modification of that used by Edwin Higgins in sampling dust in mines of the Joplin district. Preliminary experiments have shown that the old type of sugar tube had an extremely high resistance to breathing, amounting to from 15 to 20 in. at 16 litres per minute. This large resistance renders it impossible for a man to take a sample of appreciable size. As a result of experiments made with different dimensions of tubes, a size was found in which the resistance is reduced to only 3 in. of water at 32 litres per minute, and which is decidedly more efficient in removing fine dust.

On applying the standard tobacco-smoke test, it was found that the efficiency of the old type of sugar tubes was only 50%. That of the new type will probably be about 90%. Optical methods are used for determining the efficiency, and by such methods very fine particles can be distinguished—much finer than by any other method."—*Engineering and Mining Journal*, May 31, 1919, p. 950. (H. A. W.)

STRENGTH AND OTHER PROPERTIES OF WIRE ROPE.—"*Nature of Investigation.*—"The paper presents the results of tests upon 275 wire ropes submitted by American manufacturers to fulfill the specifications framed by the Isthmian Canal Commission in 1912. The samples were selected by government inspectors for acceptance tests of materials to be used at the canal zone.

The rope ranged in diameters from ¼ inch to 1½ inches, a few being of larger diameters up to 3¼ inches. Over half the specimens were plow and crucible cast steel hoisting rope of 6 and 8 strands, 19 wires each. The remainder were galvanized steel guy rope and iron tiller rope of 6 strands, 7 wires and 6 strands, 42 wires, respectively.

The investigation was made primarily to determine the tensile strengths of the ropes. Much of the experimentation was of a supplementary character—to determine the general laws of construction of the rope as the basis of the interpretation of their physical behaviour under stress. A comparative analysis was made of the chemical constituents of steels, rope fibres and lubricants of plow steel ropes submitted by different manufacturers.

Methods of Tests.—The wires at the ends of specimens were "frayed out" to form a "broom." These were inserted into moulds, into which molten zinc was poured so as to form conical sockets for connection to the testing machines. Most of the tensile tests were made on a 600,000 pound Olsen testing machine, the ropes of large diameters being tested on the 1,200,000 pound Emery machine. Stress-strain measurements were made on over half the specimens. Numerous tests of individual wires were conducted in tensile, bending, and torsion machines. The strengths of the cables were studied in connection with their modes of construction, the strengths of their component wires, and the types of fractures which were presented.

Results of Measurements and Tests.—The homologous linear dimensions of the strands, wires, and fibre cores were found to vary in direct proportion to the diameters of the ropes. The diameters of the strands and fibre cores were generally one-third the diameter of the rope. The mean pitch or lay of the strands was $7\frac{1}{2}$ diameters. The mean lay of the wires was $2\frac{3}{4}$ diameters. The mean diameter of the wires was expressed by the equation :

$$d = K \frac{D}{N+3}$$

d = diameter of wires.

D = diameter of rope.

N = number of wires in outer ring of wires of a strand.

$$K = \begin{cases} 1{\cdot}0 & \text{for hoisting and guy rope.} \\ 0{\cdot}8 & \text{for extra flexible } 8 \times 19 \text{ hoisting rope.} \\ 0{\cdot}33 & \text{for tiller rope.} \end{cases}$$

The aggregate cross sectional areas of the wires was expressed approximately by the equation :

$$A = C^1\ D^2 : C = \begin{cases} 0{\cdot}41 & \text{for } 6 \times 19 \text{ plow steel hoisting rope.} \\ 0{\cdot}38 & \text{for } 6 \times 19 \text{ cruc. steel hoisting rope.} \\ 0{\cdot}38 & \text{for } 6 \times 7 \text{ guy rope.} \\ 0{\cdot}35 & \text{for } 8 \times 19 \text{ plow steel rope.} \\ 0{\cdot}26 & \text{for } 6 \times 42 \text{ iron tiller ropes.} \end{cases}$$

It was found when the maximum loads determined from tensile tests were plotted as functions of the diameters of the ropes that the curves bounding the lower frontiers of each zone comprising the observed values were in close agreement with similar curves plotted from the minimum strengths stipulated in the specification of the Isthmian Canal Commission of 1912. These strengths were also in approximate agreement with the standard strengths recommended in 1910 by the manufacturers from the results of their tests of cables similarly classified. The minimum strengths found from the present investigation are given by the following empirical equation :

$$\text{Load} = C\ 75000\ D^2$$

D = diameter of wire rope in inches.

$$C = \begin{cases} 0{\cdot}9 \text{ to } 1{\cdot}1 \text{; mean value about } 1{\cdot}0 \text{; } 6 \times 9 \text{ plow steel cables.} \\ 0{\cdot}8 \text{ to } 0{\cdot}95 \text{; mean value about } 0{\cdot}9 \text{; } 8 \times 19 \text{ plow steel and } 6 \times 19 \text{ cruc. cast steel cables.} \\ 0{\cdot}3 \text{ to } 0{\cdot}4 \text{; mean value about } 0{\cdot}35 \text{; iron tiller, and steel guy rope.} \end{cases}$$

The modulus of the rope calculated from stress-strain measurement was found to vary from 3,000,000 to 9,000,000 pounds per square inch, depending upon the diameter and class of cable.

Plow steel ropes were selected for comparative analysis of the constituent materials. In the chemical analyses the carbon content ranged from 64% to 96%, with a mean of about 75%. The managanese ranged from 25% to 68%, the silicon from 11% to 24%. The percentage of phosphorus and sulphur was relatively low. In certain cases the steel of the filler wires was softer than the main wires.

The fibres used in making the core of the rope were estimated as manila, jute, istle, mauritius, manila fibre alone being employed by certain manufacturers. The preservatives and lubricants on the cores were composed of wood and vegetable tars, petroleum products, and fish oil, the practice varying somewhat among the manufacturers.

There was a reasonable uniformity in the strengths and elongations of the wires from a particular cable, but a larger variation in the strengths of the wires from cables of different manufacturers. This was probably due to the fact that different grades of plow steel were used by the several manufacturers in meeting the provisions of the specifications.

The cables developed from 72% to 90% of the aggregate strengths of the wires. The upper limit of the ratio of the strength of a rope to the strengths of its wires was found from theoretical considerations to be 89·2% for 6 x 19 plow steel cables. The differences between the results of the theoretical analysis and the practical tests were largely attributed to different strengths and degrees of ductility of the wires, this causing an unequal distribution of the load among the strands with over-stressing of certain strands near the point of failure."—J. H. Griffith and J. G. Bragg.—*Journal Franklin Institute*, July, 1919, pp. 123—126. (J. A. W.)

MISCELLANEOUS.

A Standard in Radiotherapeutics.—"The problem of a suitable standard of quantity for use in radiotherapeutics has received much attention, and cannot be said to have been completely solved. Most of the devices have been based on the application, as the unit, of a certain fraction of the energy required to produce inflammation or redness of the skin, but this is naturally a somewhat indefinite measure, as is shown by the fact that the ratio most commonly employed, originally one-third, is now taken as one-fifth. Mr. Bordier, in a recent communication to the Academie des Sciences, proposes as an alternative a method depending on chemical dissociation, and has devised a "chromoradiometer," providing five chief scales (based on colouration) which will suffice for all clinical cases. The unit is defined as the quantity of X-rays capable of liberating 0·1 mgm. of iodine in a cubic centimetre of a 2% chloroformic solution of iodoform of a thickness of 1 cm., and placed in the shadow of the radiation. This unit, it is contended, depends on precise physical processes, which is not the case in the methods previously mentioned."—M. Bordier.—*Ind. Engineering*, Dec. 7, 1918, p. 317. (J. A. W.)

Abstracts of Patent Applications.

569.18. S. H. C. Munro. Improvements in water blasts for use in mines. 14.9.18.

This application refers to a device in connection with a water blast, in which the air controlling valve automatically actuates the water controlling valve, so that the mixture for the water blast, of water in proportion to air, is automatically controlled.

617.18. T. J. S. Fourie. Improvements in safety arrangements for hoisting plants. 9.10.18.

This application relates to mine hoisting plant, including signalling apparatus by which instructions are sent from the despatching station to the hoist driver.

It specially applies to impulse signals, combined with the present methods of signalling, so as to automatically control the giving and receiving of signals. Other automatic safety arrangements are brought into action for different services.

239.19. Ferdinand Guy Gasche. Improvements in the concentration of ores. 5.4.19.

This application relates to a method and apparatus for classifying and concentrating minerals of varying sizes and specific gravity

479.19. H. Ford & Son, Inc. Improvements in air washer filter. 21.6.19.

This application refers particularly to motor cars or tractors, and comprises an air washing apparatus by which the inlet of air going to the carburettor is passed through a receptacle containing water. The apparatus comprises a specific arrangement of air passages controlled by floats so that when there is no water in the receptacle, the air is automatically shut off. Deflectors are also provided for to prevent the water being thrown out with the air.

496.19. R. F. Bateman (1) H. S. Hills (2). Piston hammer type of rock drilling machine and the like. 26.6.19

This application refers to a design of valve mechanism for a hammer drill, the principal modification being the use of a special valve in the top head of the machine.

583.19. A. G. N. Burden. Improvements in machines or apparatus for reducing or disintegrating minerals and similar materials. 21.9.18.

This application refers to a machine or apparatus for reducing or disintegrating minerals and such like materials, including a disc or equivalent device having guides, vanes or their equivalent which serve for conducting the material which is to be reduced or disintegrated from the central zone of the disc or its equivalent to the periphery thereof and avoiding circumferential slip due to the inertia of the material, a circular or similar anvil or impact ring against which the particles are thrown, and means for rotating the disc at a high speed, substantially as described in connection with the drawings.

589.19. E. Tribe. Improvements in and connected with pipe joints. 28.7.19.

This application refers to and is connected with pipe joints comprising a leak-preventing ring having flexible inturned edges adapted to embrace the outer circumferential surfaces of the pipe to be joined, said ring constituting an annular chamber groove, bridging the junction between the opposing ends of the pipes to be joined, whereby the pressure within the pipe operated to maintain the flexible edges of the leak-preventing ring in leak-proof engagement with the pipe. There are various modifications showing how the principle can be adopted to various classes of rigid and also flexible pipe lines.

596.19. U. C. Tainton. Method of roasting ores or concentrates. 28.7.19.

This specification describes and claims a method of roasting zinc ores or concentrates containing iron, which consists in reducing the ore by milling or grinding to a comminuted mass, blowing said mass by means of an air blast through a roasting chamber to permit each zinc and iron particle contained in the ore or concentrates to be roasted while suspended in said blast, cooling said particles after passage through the roasting chamber, and then separating said particles from the air by permitting them to settle in a collecting chamber.

598.19. H. C. Badder (1); S. F. Burrows (2), and H. L. P. Allender (3). Improvements in connection with compositions for and the production of waterproof cements, concretes and mortars. 28.7.19.

This application refers to a composition to be mixed with concrete in order to make it waterproof or non-absorbent of water.

The process consists in mixing with the concrete a certain proportion of burnt clay which has been impregnated with solutions of silicates and chlorides of potassium, sodium, zinc, calcium.

There is also a combination claimed for the use of a small proportion of sulphate of a metal or earth.

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Moir, J. S., *l/o* City Deep: Modder "B" G.M. Co., Ltd., P.O. Modderbee.

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Vol. XX DECEMBER 1919. No. 6.

THE SOLUBILITY OF ZINC IN CYANIDE SOLUTIONS.*

By H. A. White (Member of Council).

Very little research on this subject has been published, though it is one of great importance in reference to the precipitation of gold from cyanide solutions. In fact, quite a large proportion of the world's gold output depends upon the reactions we are to consider. The main object of the experiments made was to observe the effect of various conditions which in practice might affect the consumption of zinc, and particularly the concentration of cyanide, alkalinity, and oxygen present. As there is probably some disadvantage in practice in dissolving more zinc than absolutely necessary to keep the extractors working efficiently, in this case a minimum rate of solution is of much more interest than is the case where gold is the object of attack.

The main reaction, in presence of oxygen, and with such concentrations of cyanide and alkali as are now in use is:—

$$Zn + 4KCy + O + H_2O = K_2ZnCy_4 + 2KOH$$

65·37 : 260·44 : 16·0 : 112·22
1·000 : 3·984 : 0·2448 : 1·717
0·251 : 1·000 : 0·0618 : 0·4309
0·086 : 16·277 : 1·000 : 7·014
0·582 : 2·321 : 0·1426 : 1·000

Therefore 6 mgm. of oxygen per litre is equivalent to 0·0089% KCy and to 24·5 mgm. of zinc per litre or 0·049 lb. of zinc per ton of solution.

However, it must be pointed out that, even in the absence of oxygen, some zinc may go into solution in accordance with the following equations:—

$$Zn + 4KCy + 2H_2O = K_2ZnCy_4 + 2KHO + H_2$$
$$Zn + 2KAuCy_2 = K_2ZnCy_4 + 2Au$$
$$Zn + PbCy_2 + 2KCy = K_2ZnCy_4 + Pb$$
$$Zn + Na_2S_2O_3 = ZnS + Na_2SO_3$$
$$Zn + 2NaHO = Na_2ZnO_2 + H_2$$

The first and last of the above reactions were formerly of greater importance than at present, and their rate is increased, in presence of a zinc-lead or other couple, and high concentrations of cyanide or alkali.

The fourth equation represents the reaction by which is formed the zinc sulphide coating so commonly found, and this matter deserves more attention than it has yet received.

Experimental.

The results are generally expressed in milligrams of zinc dissolved per square centimetre of exposed surface per 24 hours, which tacitly involves the assumption that variation of time or surface will yield proportionate figures, which is not necessarily exactly true, but gives a convenient comparison among different sets of experiments.

The zinc used was ordinary commercial sheet rolled down to about 0·3 mm. thickness and cut into rectangles 2·5 × 1·5 cm. After exposure, the pieces of zinc were washed in strong ammonia to remove any oxide formed, then in distilled water, and carefully dried with filter paper.

In each set of experiments the conditions were as nearly as possible alike, but no attempt was made to hold temperatures constant. Concentrations were determined before and after in each case, but only the average figures are quoted.

(1) Influence of oxygen concentration.

(a) De-aerated solution.

A piece of zinc giving 7·5 sq. cm. of surface was suspended by a thread attached to a shaped glass rod in each of 5-300 cc. stoppered bottles with solutions of varying cyanide strength, and no excess alkalinity, for 41 hours in moderate light. Temperature at start 38°C., at finish 27·5°C. Oxygen determined before start was 1·0 mgm. per litre, and at end about 0·5 mgm. per litre in each case.

---

*This paper will be submitted for discussion at the General Meeting of the Society to be held on the 21st February, 1920.

KCy. %	Oxygen mgm. per litre.	Zinc dissolved mgm. per sq. cm. per 24 hours.
0·100	0·75	0·13
0·050	0·75	0·16
0·030	0·75	0·17
0·020	0·75	0·18
0·010	0·75	0·19

With so little oxygen present the action is very slow and cyanide strength is of little importance. More than twice as much zinc is dissolved than corresponds with loss of oxygen, so that, unlike the case with gold, zinc is able to displace hydrogen in such solutions to a small extent.

(b) Aerated solution.

The same pieces of zinc as in 1 (a) were used, but solutions were made up with Rand Water Board water, precipitated with excess lime, so that the average alkalinity was 0·040% NaHO. 500 cc. jars open to air and moderate light were used, the zinc being hung on glass rods with thread. Temperature before trial 26°C. Oxygen at start 7·0 mgm. per litre. Exposure, 17 hours.

KCy %	Oxygen m p.l.	Zinc dissolved mgm. per sq. cm. per 24 hours.
0·050	6·5	0·75
0·025	6·5	0·76
0·020	6·5	0·78
0·015	6·8	0·78
0·010	7·0	0·37

With plenty of oxygen present, cyanide strength is of importance, showing a maximum at about 0·020%. Even without use of zinc-lead couple, the importance of removing oxygen is manifest on comparing results in 1 (a) and 1(b).

Figure 1 shows the above results graphically.

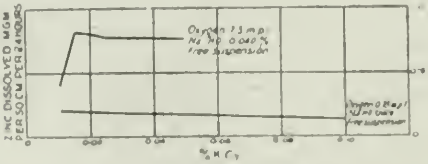

Fig. 1.—Influence of oxygen on solution of zinc in cyanide solutions.

(2) Influence of cyanide strength upon solution of zinc, with electrolytic contact.

(a) In contact with carbon.

Pieces of zinc, 2·5 × 1·5 cm. were each bound to two carbon rods, of total surface 150 sq. cm., and placed at the bottom of 500 cc. glass jars, filled with cyanide solutions of various strengths, and exposed for 19 hours. The alkalinity at the beginning was 0·0144% NaHO, the oxygen 6·5 mgm. per litre, and the temperature at start was 26°C., finishing at 25°C.

KCy %	NaHO.	Oxygen m.p l.	Zinc dissolved mgm. per sq cm. per 24 hours.
0·040	0·0120	4·0	3·12
0·025	0·0121	4·5	2·72
0·020	0·0122	4·5	2·76
0·010	0·0118	4·5	2·67
0·005	0·0118	4·5	2·62

The top side of the zinc was covered with white precipitate in half an hour in each case.

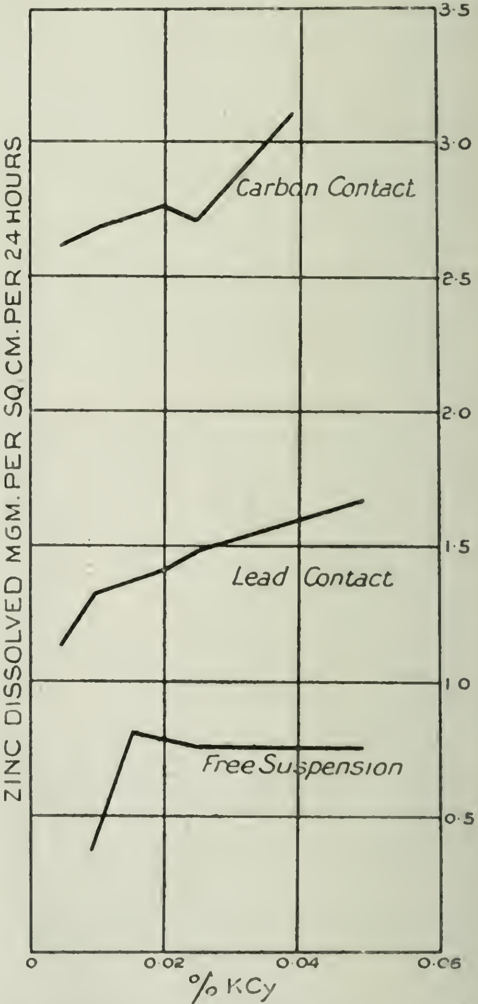

Fig. 2.—Influence of cyanide strength on solution of zinc in jars open to air.

(b) In contact with lead.

Pieces of zinc, as in (2) (a), were balanced on top of lead cylinders made with lead foil, 3 × 5 cm., giving a lead surface of 30 sq. cm. 500 cc. glass jars were used, and the time of exposure was 18½ hours. Alkalinity at start was 0·0144% NaHO. Oxygen was 6·5 mgm. per litre. Temperature at start 24°C., finishing at 15°C.

KCy %	NaHO.	Oxygen in p.l.	Zinc dissolved mgm. per sq. cm. per 24 hours.
0·050	0·0130	5·0	1·67
0·025	0·0124	4·5	1·47
0·020	0·0122	4·5	1·42
0·010	0·0122	5·0	1·32
0·005	0·0122	5·0	1·25

While no white precipitate was apparent with the 0·050% KCy, increasing amounts appeared in the other cases as the cyanide strength was reduced.

Figure 2 illustrates the great increase in consumption of zinc caused by contact with carbon, the lead contact results being intermediate with those of plain suspension.

(3) Influence of alkalinity upon solution of zinc in presence of 0·030% KCy.

(a) Freely suspended. (b) In contact with lead.

The zinc and lead were used in exactly the same manner as in (2) (b) in 500 cc. open jars. The alkalinity was obtained by means of dilution of lime water, and the cyanide strength was made up to 0·030% in each case originally. The temperature at beginning was 27°C., and after the 18½ hours' exposure was 24°C.

		Zinc dissolved mgm. per sq. cm. per 24 hrs.	
NaHO.	KCy.	Free suspension.	Contact with Lead.
0·0456	0·030	0·47	1·20
0·0284	0·030	0·45	1·20
0·0115	0·030	0·45	1·21
0·0054	0·029	0·52	1·26
0·0020	0·021	0·50	1·18

In the first two solutions a trace of lead was visible on adding sodium sulphide and acetic acid, and in the third a very little white precipitate was seen.

It is evident that, with free cyanide as high as 0·030%, alkalinity variations have very little effect.

Figure 3 illustrates above figures.

(4) Influence of alkalinity upon solution of zinc in presence of 0·010% KCy.

(a) Freely suspended. (b) In contact with lead.

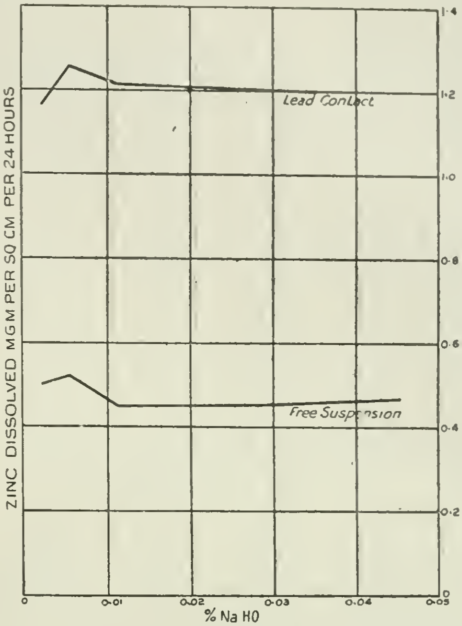

Fig 3.—Influence of alkalinity on solution of zinc in jars open to air in presence of cyanide equal to 0·030% KCy.

The conditions were the same as in (3) (a) and (b), except that cyanide strength was made up to 0·010% in each case and the exposure was 18 hours. Oxygen at beginning was 7·0 mgm. per litre. Temperature at start 29°C., and end 23°C.

			Zinc dissolved mgm. per sq. cm. per 24 hours.	
Na HO.	KCy.	Oxygen m.p l.	Free suspension.	Lead contact
0·0463	0·010	7·0	0·28	0·24
0.0295	0·010	6·0	0·27	0·25
0·0113	0·010	4·7	0·31	1·23
0·0052	0·010	4·7	0·40	1·29
0·0010	0·008	4·7	0·38	0·68

White precipitate appeared only in the third and fourth cases, and in the first two cases the lead had been attacked, the solution showing a heavy precipitate of lead sulphide in the first case and somewhat less in the second. There is evidently an inversion point in the electrolytic effect, at this cyanide strength, with solution above 0·030% NaHO, and such high alkalinity might endanger the work of the extractor boxes at low cyanide strengths.

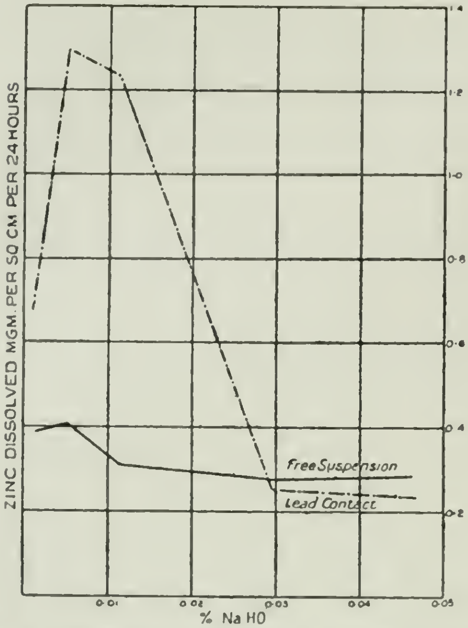

Fig. 4.—Influence of alkalinity on solution of zinc in jars open to air in presence of cyanide equal to 0·010% KCy.

Figure 4 is drawn from above results, and should be compared with figure 3 to see the extraordinary difference which is produced by decrease of cyanide strength from 0·030 to 0·010%, and this is corroborated by Figure 5, where the effect of entirely removing the cyanide is shown.

(5) Influence of alkalinity upon solution of zinc in absence of cyanide.

(a) Freely suspended. (b) In contact with lead foil.

In both cases the alkalinity, though reported as NaHO was obtained by dilution of lime water. In each 500 cc. jar used one piece of zinc, 2·5 × 1·5 cm., was suspended by cotton thread, and one piece was balanced on a lead cylinder of 30 sq. cm. area, as in experiment (2) (b) Exposure was for 18½ hours, the temperature at start being 28°C., and at finish 24°C. Oxygen at beginning, 7·0 m.p.l.

		Zinc dissolved mgm per sq. cm. per 24 hou	
NaHO.	Oxygen.	Free suspension.	Lead contact.
0·0412	7·0	0·00	0·03
0·0272	5·5	0·07	0·75
0·0176	5·7	0·32	0·85
0·0078	5·5	0·33	1·04
0·0018	5·7	0·31	1·14

No white precipitate appeared in the first and last cases, but a little was shown on both pieces of zinc in all the others. In the first two cases the lead foil was discoloured. It is very clear that such unusually high alkalinity as 0·040% NaHO practically hinders the reaction completely, and is reminiscent of the protective action of alkalies in boiler-feed water, where a certain minimum dose is required before protection commences. It is clear, however, that the alkalinity in cyanide solutions might be run up to 0·030% as NaHO without danger of interference with precipitation.

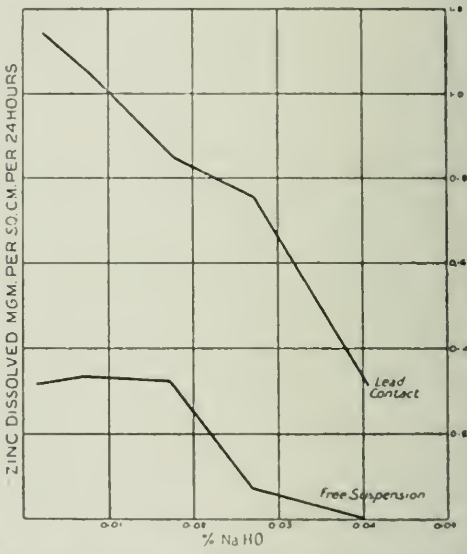

Fig. 5.—Influence of alkalinity on solution of zinc in jars open to air. No KCy present.

Figure 5 is drawn from above figures.

(6) Effect of gold-bearing solutions upon zinc, in the absence of oxygen.

Condensed water containing 0·75 mgm. per litre of oxygen was used for these experiments, in 300 cc. stoppered bottles. A strip of zinc 10 × 1 cm. was used in each case, and sodium auro-cyanide equivalent to 7·0 mgm. of gold per litre was placed in each bottle. In B and C a strip of lead measuring 5 × 5 cm., rolled into a cylinder, was placed to rest against the bottom of the zinc strip. In B the cyanide strength was made 0·021%, and in D 0·027%.

The temperature at start was 27°C., and after the 18 hours' exposure was 24°C. Allowance was made for the gold precipitated in calculating the weight of zinc dissolved.

	KCy.	NaHo.	Gold pptd. mgm.	Zinc dissolved mgm. per sq. cm. per 24 hours.	
A	0·000	0·0008	0·00	0·08	
B	0·021	0·0020	1·76	0·68	(Lead contact.)
C	0·000	0·0048	0·15	0·13	(Lead contact.)
D	0·027	0·0016	0·56	0·53	
E	0·000	0·0048	0·00	0·10	

In A and E the absence of free cyanide totally prevented precipitation of gold, though a little white precipitate was formed. In C, though no cyanide was present, the zinc-lead couple was able to precipitate a little gold in black splashes and a trace of lead went into solution.

In D, in presence of free cyanide, the zinc alone was able to precipitate a fair amount of gold (in an even black coat). In B the zinc-lead couple began to get dark in 20 minutes, and though not much more zinc was dissolved than in D, nearly three times as much gold was precipitated. In this case the zinc dissolved was 10 times the amount corresponding with the oxygen present, and 18 times that equivalent to the gold brought down and only the direct production of hydrogen can be called on to explain the differences.

Evidently the ideal of consuming only as much zinc in the extractor boxes as would correspond with the gold and silver precipitated calls for close regulation of the cyanide strength and alkalinity, as well as the total absence of oxygen, and does not seem likely of attainment even in the absence of other side reactions such as the reduction of thiosulphates.

The actual consumption of zinc in the usual extractor boxes will average about 0·18 mgm. per sq. cm. per 24 hours, or about 3 times that rate in the first compartments, before the bulk of the oxygen is removed.

It is not possible to give an average figure for zinc consumed per ton of solution treated on the Witwatersrand, but a moderate assumption would be 0·1 lb. of zinc per ton of solution, carrying 2 dwt. of gold per ton. The various sources of this consumption would be roughly:—

Gold and silver precipitation	1·2%
Combination with dissolved oxygen	49·0%
Evolution of hydrogen	4·8%
Taken for clean-up	33·0%
Used to precipitate lead in "dipping," waste in cutting, used in forming ZnS coating, etc.	12·0%

These figures are, of course, merely illustrative and are for the purpose of drawing attention to the present wasteful inefficiency of our present methods of gold precipitation.

A GENERAL REVIEW OF THE ECONOMIC RESULTS ATTENDING THE GOLD AND BASE METAL MINING IN THE PRETORIA INSPECTORATE DURING THE PERIOD 1904 TO 1914.

By Tudor G. Trevor (*Member*).

(*Printed in Journal, October, 1919*).

DISCUSSION.

Prof. J. Cellier (*Member*): I have read with considerable interest Mr Trevor's paper, and think he can be congratulated on the very useful information and statistics—not otherwise available to everybody, except with much labour—placed before us. A consideration of the figures shows that during a period of 10 years the following amounts have been spent on properties ultimately abandoned:—

141	Exploration prospecting, @ £500 each	£70,500
122	Development, @ £2,500 each ...	£305,000
131	Producing, @ £10,000 each...	£1,310,000
394		£1,685,500

The total is still further increased when 419 ventures eventually proved a failure and 17 are still doubtful.

This amount of money is virtually lost to the country, excepting for that proportion which is paid for local products and in direct taxation.

The failing of some 90-94% of ventures has a very depressing effect on future expansion, and would tend to decrease future production.

Such failure will, no doubt, never be entirely eliminated, for "nothing venture nothing win." A large proportion of the capital thus lost could, however, be directed to better purpose if the investors were well advised.

In this country technical advice is obtainable only from privately practising men, and from the consulting engineers of the groups, who may not always be unbiassed. Added to this is the fact that the expense entailed for such advice may also be considerable.

In the Director and Assistant-Director of the Geological Survey, the country has most capable men, but the enormous area still to be mapped and the smallness of the staff obviates use being made of them to the extent necessary.

The Inspectors of Mines in outlying areas are of assistance, but their time, also, is largely taken up by attending to the enforcement of regulations tending more to safety on producing properties than to the development of future producers.

What would be of enormous assistance to the investors in such properties as have failed, is the appointment, at State expense, of an inspecting engineer to the Mines Department; the conditions suggested of such appointment to be, say:—

1. Salary and transport expenses not to exceed £1,500 and £500 per annum.
2. South African by birth, if possible, and certainly by experience.
3. Experience of both underground and surface equipment, and of South African geology, and particularly mineral occurrences.
4. Duties to be devoted entirely to properties in a non-profit-making condition, or to those willing to pay fees when possible.

Free technical advice is available in this country to farmers, through the Veterinary Department, to many poor people through the hospitals, and it also should be available to an industry which in 10 years produces in direct taxation alone an income of £791,352 in but one of the Mining Inspectorates of the Union.

The cost would be £20,000, or about 2·5 % of the income, or 1·25 % of the amount spent on abandoned properties.

The correct working of the successful properties, owing to competent technical advice, alone might increase the income so as to more than pay for the expenditure, but the saving effected by such advice at the early stages of properties abandoned later would, no doubt, result in a loss in claim licenses.

The idea is not that the State should find the mine and work it for nothing for the owner, as sometimes seems to be desired in farming operations, to find scab and kill it for the owner, or to store water and irrigate for the owner.

Suggestion of such a post is not a method of applying for it by the speaker, and its limitation to South Africans is not due to any political tendency, but simply because experience of local conditions takes some time to acquire, and the sooner it is obtained the better.

The remarks on the Department of Geological Survey and Inspectors of Mines are not a reflection on these, but, as pointed out, a whole-time man with good mining experience and true mining duties is desirable.

AMALGAMATION: WITH SPECIAL REFERENCE TO STEAMING.

By S. H. Pearce and J. E. Thomas (Past-President).

(Printed in Journal, November, 1919.)

DISCUSSION.

Mr. E. M. Weston *(Member of Council)*. Absence from town prevented my correcting the proof of my remarks in the November Journal (page 79). The reported apparently misunderstood me, and made me say: "Having no scientific facts or arguments in support of this revolutionary statement, my suggestions are not approved by our leading metallurgists."

On the contrary, I have always maintained that scientific facts support my contention that amalgamation as now practised is unnecessary; and I am now preparing a paper on the subject which I hope shortly to bring before the members. One metallurgist apparently does not regard my ideas as unscientific, and he has already modified his practice.

Mr. J. D. O'Hara *(Member)*: I think everyone is agreed that this subject is most important, in view of the fact that steaming is injurious to health. If precautions were taken to carry the fumes from the steam box outside the building, and allow a few minutes to elapse to enable any remaining fumes to escape, after the box is removed, there would be fewer complaints of illness after steaming days. Unfortunately, the general tendency is to start work immediately steaming is completed.

I certainly consider steaming is necessary, because it is generally admitted that amalgamation is better after plates are steamed than is the case with plates which have not been steamed for some time.

The reasons for steaming, I venture to suggest, are:

1. Steaming makes a plate "livelier," livening the surface of the copper plate.
2. Scouring after steaming removes all the dirt which has accumulated and hardened on the plate, due to the lime in the mill water. A good scouring will always benefit a plate which has not been amalgamating too well.
3. Plates are steamed to meet the call for more gold, and because more gold is required for the particular period.
4. More amalgam than necessary is kept on plates to meet calls for more gold in some months, and when in that case more gold is recovered, one is then told in all seriousness that amalgamation is much better than usual, and the real reason is overlooked.

The statement is often made when certain plates have to be steamed that "there is no gold on them and it is useless steaming," but it often occurs that, after steaming has taken place, more amalgam is returned than was expected. A copper plate is a means for catching gold and not for storing it, and the old custom of using it as a store-house is fast dying out and should not now be permitted. The question of comparing the percentage of gold recovered by steaming with that recovered when not steaming really does not arise, nor can one compare amalgamation on mines on various parts of the reef, owing to the varying states of fineness in which the gold exists, the tendency being for the gold to become finer as one travels from West to East. The advent of tube mills is practically doing away with mill plates and amalgamation to-day is becoming confined to tube plates.

Research work has proved that with careful, if not perfect, classification, low residues can be obtained without amalgamation before tube milling, and I fail to see any necessity or reason for using plates until the ore has passed through the tube mills. The adoption of this principle is an undoubted economy in that it saves plates and labour, and a higher efficiency is obtained in crushing and amalgamation.

In conclusion, although I may have wandered away from the question of steaming, the points dealt with bear directly and indirectly on the report submitted by Messrs. Pearce and Thomas.

OBITUARY.

Mr. R. C. Boyes.

The death is recorded, with regret, of Mr. Reginald C. Boyes, who joined the Society as a member in September, 1916.

Mr. Boyes, who was born in Sheffield, went to Australia when young, and was there educated as a mining engineer. He came to this country during the South African War, under General Hoade, and upon demobilization returned to his profession, practising both on the Rand and in Rhodesia. For some years prior to his decease he held the position of General Manager of the Great Belingwe G.M. Co. Following an accident to his arm, blood poisoning set in, from which he died on the 19th October.

Notices and Abstracts of Articles and Papers.

CHEMISTRY.

Smelting and Refining of Cobalt Silver Ore.—"At the Deloro Reduction Co.'s smelter, silver-cobalt ore is smelted in a blast-furnace (run with 6—8 oz. blast pressure on account of the large proportion of fines), the charge being calculated to furnish speiss and a neutral slag. The speiss contains Co 22—25, Ni 16—18, As 25, Fe 18, S 7, Cu 1%, and 1000—2000 oz. Ag per ton; it is first liquated to recover part of the silver, then ground, roasted, chloridised, washed with water, and treated with cyanide. The silver is precipitated from the solution with aluminium dust, the cyanide being almost quantitatively regenerated. The liquated and the precipitated metal are melted in an oil-fired furnace which is tilted backwards into blowing position; the metal after 3 hours' blowing is 992—995 fine, and is refined by another melting. The desilverised speiss is sulphatised and leached; the liquor is first freed from copper and iron, cobalt precipitated with hypochlorite solution, and nickel, after removal of the cobalt, with milk of lime. The hydroxides are filter-pressed, washed, and dried ready for sale, or mixed with charcoal and reduced; the crude metals are separated magnetically from excess of carbon, re-melted in electric furnaces, and granulated by pouring into water. The dust and fume from the various furnaces, collected in a bag-house, are heated in a coke-fired reverberatory, and the pure arsenic trioxide condensed in chambers. The clinker from this operation goes back to the blast furnace for the recovery of silver."—S. B. Wright.—*Journ. Soc. Chem. Ind.*, Feb. 15, 1919, p. 77a. (J. A. W.)

Some Properties of Magnesium Ammonium Phosphate and Magnesium Pyrophosphate.—"The conversion of magnesium ammonium phosphate into magnesium pyrophosphate may or may not be accompanied by the phenomenon of incandescence, depending upon the conditions under which the magnesium ammonium phosphate is precipitated. The product will not incandesce if precipitated slowly at the boil, but will do so if formed quickly or at lower temperatures. It has been found that incandescence never takes place if all traces of organic matter are carefully excluded from the precipitate. The properties of magnesium pyrophosphate depend upon whether it is formed with or without incandescence. If incandescence occurs, the product is hard and lava-like, and grey to black in colour, whilst if there is no incandescence, it is amorphous, loose in texture, and quite white." (See also *J. Chem. Soc.*, Feb. 1919.)—Z. Karaoglanow and P. Dimitrow. *Z. anal. Chem.*, 1918, 57, 353-371.—*Jour. Soc. Chem. Ind., Jan.* 31st, 1919, p. 10A. (A.W.)

Use of Manganese Di-oxide Ore.—"The quantity of manganese ore used in industries other than metallurgical varies from 25,000 to 50,000 tons per annum. The latter figure is probably more nearly correct. Most of the ore so used is the highest grade of pyrolusite (MnO_2) obtainable, and commands a much higher price than metallurgical ore. The manganese di-oxide ore is generally spoken of as chemical manganese ore.

The principal use of manganese ore, aside from its applications in the steel industry in the form of ferro-manganese and spiegeleisen, is as an oxidizing agent. It is so used principally in the manufacture of dry cells, as a decolorizer in certain kinds of glass, and as a drier in oils, paints, and varnishes. The ore is also used directly or indirectly in the manufacture of various manganese chemicals. Many of the textbooks describe its reaction with hydrochloric acid as a source of chlorine. It is no longer used commercially in making chlorine gas, as the latter is an abundant by-product in the manufacture of caustic soda and potash. Some chlorine may be made by this method when the object is the production, not of chlorine, but of manganese chloride. It has been mentioned as a soil stimulant, but its value in the fertiliser industry has not been established, and so far as known it is not a constituent of any commercial fertilizer.

The gasoline engine gave the development and production of the present type of dry cell great stimulus. Its use in ignition systems demanded a cheap portable cell able to recuperate after comparatively heavy current drains. In 1897, its manufacture attained considerable volume. The present normal yearly requirements of this production include 25,000 tons of high-grade manganese di-oxide ore, an equal amount of carbon (petroleum coke and graphite) and 8,000 to 10,000 tons of sheet-zinc chloride, ammonium chloride, paper, carbon electrodes, pitch, and sundry other substances."—Abstract from *Minerals Investigation Series*, No. 16, of U. S. Bureau of Mines.—W. C. Phelan, *Mining and Scientific Press*, June 28, 1919, p. 874. (H. R. A.)

METALLURGY.

"Diseases" of Metals.—"As a result of allotropic changes, many metals exhibit phenomena of disintegration or decay which are commonly likened to diseases. The analogy is often rendered more complete by the fact that very often such processes of decay are infectious, and fragments of metal which have undergone disintegration have often shown a tendency to communicate the decay to other fragments of unattacked metal with which they come into contact.

In discussing such phenomena, Colonel Krynitsky, late Chief Inspector of Time Fuses to the Russian Government, describes a number of instances which have been observed with tin and aluminium, and shows the connection between such allotropic changes and those which are met with in steel when annealed after cold work.

He is of opinion that when the tin is mechanically worked it is more or less converted into amorphous tin, depending on the amount of cold strain, and that the latter undergoes recrystallisation with accompanying disintegration of the metal.

Following on this idea he draws an analogy with the well-known behaviour of steel which has been subjected to cold work. As previously mentioned in these columns, it has been shown that when such steel is annealed at 600° C. the grain grows in size and the metal becomes brittle.

Some instances are described in which aluminium vessels had failed after a very short period of service. According to some experiments made by Le Chatelier, the decomposition of aluminium may be produced by mild chemical or mechanical action, such as may take place in a utensil over a flame or when containing hot liquids. This is particularly noticeable with aluminium which has been heavily forged, especially in contact with lime water.

The failure of brass cartridge cases may also be regarded as instances of similar behaviour. It is well known that large brass cases which have been manufactured by cold drawing without proper annealing are liable to spontaneous cracking. Such cracking takes place after the cases have been in use for some time, but the tendency to crack may be detected by plunging them into a bath of mercuric chloride, when a crack at once develops. It is supposed that during the process of cold work films are formed along the surfaces of slip which consist of metal in an amorphous condition. Subsequently the metal gradually tends to pass out of this unstable condition, and the amorphous metal becomes recrystallised."—(*Chem. and Met. Eng.*, *1919*, 277.) *Industrial Australian and Mining Standard*, 28th August, 1919, p. 389. (C. J. G.)

Porosity and Volume Changes of Firebricks.—Mr. George A. Loomis, in a paper published by permission of the Director, U.S. Bureau of Standards, and giving an account of the results of an investigation undertaken in order to study the fundamental properties of firebricks by a comparison of their changes in porosity and volume upon heating to different temperatures, states that the determination of the softening point is generally considered a reliable indication of the refractoriness of the material. Actually, however, it is apt to be misleading, especially in the case of bricks made from a coarse mixture of very refractory non-plastic clay with an inferior bond clay. The following is a summary of the results given by the author :—(1) Bricks which are capable of withstanding a pressure of 40 lbs. per square inch at

1,350° C. generally show slight changes in volume or in porosity when burned at temperatures up to 1,425°. (2) The greater number of the bricks which failed to pass the load tests show rather marked changes in volume or in porosity at some temperature below 1,425°. (3) Bricks which show distinct overburning by pronounced expansion at temperatures below 1,400° invariably fail in the load test. The adoption of a definite limit for the permissible expansion within the given temperature range is particularly important for detecting inferior clay refractories. The limit for expansion should be lower than that for allowable contraction. (4) The changes in volume and porosity of brick burned at some temperature between 1,350° and 1,425° serve, in a measure, as a criterion of their ability to pass the load test. (5) Most of the bricks which show a porosity decrease not exceeding 5% and a volume change not exceeding 3% (about 1% in linear dimensions), when burned at 1,400° will pass the load test. (6) Bricks which show a decrease in porosity exceeding 5%, or an expansion or contraction in excess of 3% by volume (1% in length) at 1,400° failed to pass the load test in nearly all cases. (7) The use of limiting porosity and volume changes for clay firebricks burned at 1,400° C. would serve as a means of elimination from consideration a large number of bricks which fail in the load tests. (8) Bricks which fail in the load test—due to failure in the bond—may not show marked changes in volume or porosity in burning, but often show very low cold-crushing strength. (9) No definite relationship seems to exist between the softening point of a firebrick and its ability to withstand load at high temperatures. However, all bricks which softened below Cone 28, whether siliceous in character or not, failed completely in the load test. It seems advisable, then, to specify Cone 28 as the minimum softening point for any clay firebrick. It is probable that bricks containing less than 65% SiO_2 should have a minimum softening point of Cone 31."—G. A. Loomis, *Indian Engineering*, June 28, 1919, p. 359. (J. A. W.)

MINING.

The Use of Explosives in Canadian Mines.—" The tendency of users of explosives in Canada to-day, particularly in mining, is to use the lowest strength explosive that will break their ground when it is properly drilled. Up till a few years ago considerable amounts of "gelignite" (a 75% N.G. explosive) were used in the mines in Porcupine, Cobalt and British Columbia, but this has been replaced by 60% and often 50% explosives and a lowering of costs has followed. To-day by far the larger proportion of high explosives used in the mines of Canada is of 40% strength, while little 60% is used. This is due not only to the more careful supervision given to the use of explosives, but also to the fact that greater care is taken to see that the drilling is done properly."—H. Y. Russell.—*The Canadian Mining Journal*, Paper presented to the Canadian Mining Institute, March, 1919; 30th July, 1919, p. 563. (C. J. G.)

A Study of Shovelling Applied to Mining.—" From a series of tests during which the ore was thrown into a mine truck 42in. high, it was determined that a horizontal interspace of 4ft. was the best distance to maintain between car and ore-pile. The decrease in shovelling speed amounts to about 8% per foot of height. The best type of truck for a shoveller to use holds about a ton of ore, and should be as low as is consistent with good design, certainly not over 45in. in height. Trucks much larger than this are too hard to tram, while trucks much smaller use up too much time tramming back and forth. For short jobs of less than four hours' duration, the No. 2 scoop and Nos. 5 and 6 shovels were slightly superior from the standpoint of tonnage handled; but for jobs requiring more than four hours for their completion, the No. 4 shovel was greatly superior, for with the larger tool, as the day progressed, the percentage of time required for resting becomes greater. In general it may be said that for shovels smaller than 21lb. load, the tonnage handled per shift is approximately directly proportional to the shovel capacity. If the increased cost of shovelling with a smaller shovel, or one that has been worn, is balanced against the cost per ton of putting a new shovel underground and discarding the old one, it will indicate the economic limit of wear of the shovels in use. The tests went to show that the shovel best adapted to mining work should have the edge of the blade, whether square or round pointed, made of No. 15 gauge, and of such composition that the shovel will handle not less than 1,100 tons of medium hard ore when shovelled off planks. The blade should hold 21 lb. of broken ore as an average load. All blades should be of the plain-back type without rivets, the back strap being welded to the blade. Only best grade, second growth, northern white ash should be used for the handle, which should be bent to a suitable shape. On short-handled shovels, the Dirigo, or split D, handle is preferred, as it is much stronger than the ordinary D handle. For a short handle shovel the straight portion should be 22½in. long, and when the blade is in the proper position to fill the ore, the grip should be 23in. above the ground. For a long-handle shovel, the straight portion of the handle should be 34in., and the grip 30in. above the ground. The square blades are a little wider at the point than at the rear, and the front corners are cut off so as not to dig into the shovelling board."—G. Townsend Harley.—*Industrial Australian and Mining Standard*, reprinted from E. & M. J., 5th June, 1919, p. 1,022. (C. J. G.)

MISCELLANEOUS

Technical Writing: Naturalness.—"The keynote of good writing, as of good manners, is *B natural*. Sincerity is the first requisite for effective writing. When a man says what he knows or believes, he is likely to be interesting, because each human being possesses an individuality, a point of view, or a range of sympathy that makes him different from his fellows. To say or to write what you do not think, for the mere sake of talking or writing, is a cerebral exercise that must be performed with extraordinary skill if it is to be attractive. Affectations are rarely attractive, rarely effective. To be natural is to be yourself, not a *poseur*; to give the reader the best of yourself, instead of re warming the baked-meats of yesterday. Quotations—which are second-hand thoughts—will serve occasionally when the thing you want to say has been said so well by another that it would be waste of energy to try to say it better; but, as a rule, the utterance of the writer himself is more interesting than the quotation, because the writer brings something of himself to bear on the subject and for the moment is more in touch with the reader than any dear departed author. Therefore, say things as best you can in your own way, neither in borrowed words nor in the phraseology that mimics another. Write as if you were speaking to a person whom you are anxious to persuade or convince. You will then write better than you speak, because, in the first place, you can be more deliberate, and secondly, you can revise what you have written.

Speaking and writing are similar mental acts, with a difference: the difference between eating food raw and eating it cooked. Some kinds of food gain nothing by being cooked; likewise some kinds of utterance are not bettered by being written down first; but most expressions of thought, especially those that deal with complex ideas, must undergo preparation before they may be digested comfortably. The transactions of engineering societies are overburdened with half-baked chunks of knowledge that provoke mental dyspepsia. How palatable, on the other hand, is the carefully prepared article that has been seasoned with Attic salt, served with a *sauce piquante*, and dressed with the parsley of pleasant fancy like the writings of Rossiter Raymond or of Clarence King.

Composition, however, is less natural than speaking. The pen or the pencil intervenes between the thought and the expression, introducing an element of artificiality, as well as one of deliberation. The spoken work cannot be recalled; the written word can be erased. Yet it is unwise to criticise your writing as it proceeds, for such self-criticism tends to embarrassment or self-consciousness. Revise the work carefully after it is done, not before, so as to avoid chilling the warmth of composition by cold analysis. You have heard of the centipede that was too much aware of his many legs, and became hopelessly entangled. Inopportune self-criticism will cripple writing, just as self-consciousness prevents most men from becoming satisfactory after-dinner speakers.

To be natural in writing, you must have something to say: something concerning which you feel impelled to write. To have something to say is the first requisite for effective speaking or writing. Most speeches and many writings are ineffective, if not worse, because, like an unhappy golfer, the speaker or writer does not see the object of his aim; he does not "keep his eye on the ball." Wait until you have something definite to tell. Only a fool talks for the sake of talking; that is why so many speeches are flat. It is unnatural for a man to write for the sake of exercising his index finger and thumb; that is why so much writing is a weariness of the flesh. Make sure that you have something to say; then say it; and when you have said it, stop. 'The best spoke in the wheel is the fittest, not the longest.'

The story is told that President Wilson, when a boy, used to read to his father whatever he wrote. Whereupon his father would ask. 'What do you mean by that?' He would explain. 'Then write it,' was the advice. If, after writing something you will ask yourself 'What do I mean?' you may discover that you have not written what you meant to say.

The student while at college, and for some time afterward, is occupied mainly with the effort to acquire knowledge. To write is to convey information to others, which is the reverse of the normal youthful attitude; it involves a pose difficult to assume gracefully or effectively without practice; but such practice should be encouraged, because the effort to record thought involves the mobilization and marshalling of ideas, a disciplinary effort highly beneficial to the student's mind. Therefore it were well if some exercise in writing could be taken during the early process of acquiring knowledge.

To write naturally, you must exercise the faculty of writing until it becomes flexible and strong. The best way to learn how to swim is to plunge into the water. Most of those that write well have written a good deal, but you may be sure that they have not published all of it. Do your preliminary cantering in the paddock, not on the race-course. Good writers obtained their reputation by being wise enough to keep their preliminary trials to themselves: meanwhile, they noted the results obtained from the methods used by others. Ben Jonson said, 'For a man to write well there are three necessaries: to read the best authors, observe the best speakers, and much exercise of his own style.' Naturalness comes from exercise, not lack of care.

Aristotle said, long ago: 'Naturalness is persuasive and artificially the reverse; for people take offence at an artificial speaker, as if he were practising a design upon them, in the same way as they take offence at mixed wines.'

Some technical writers, aiming to be natural, succeed only in being sloppy.

(1) 'If it is inconvenient to keep the *muck* [waste rock] drawn off, tap the *dirt-way* [ore-chute] a few feet up, on the opposite side of the man-way.'

The writer is describing a method of mining and uses the language of an uneducated labourer, perhaps with the idea that it sounds 'practical.' Here are two more examples:

(2) 'With the *advent* [completion] of the new mill, which has a capacity of over 100 tons per day, the haulage problem becomes *one for careful consideration* [important].'

Advent means the season before the Nativity; it is also used when referring to an important arrival, not the starting of a stamp mill. The last sentence in the quotation exemplifies the use of an abstract phrase instead of a concrete word. The language is 'natural' to a semiliterate promoter but not to an educated engineer. Do not mistake vulgarity for ease, nor inaccuracy for freedom.

(3) 'The process is said to have done such satisfactory work that other *plants* [operators] have been *contemplating* [considering] the *installation* [adoption] of *the process* [it].'

This also illustrates an uncouthness that simulates naturalness. The writer, a graduate of a university, has fallen into the style of those about him in a mining community. The 'contemplation' of plans, the 'installation' of plants, the 'inauguration' of methods, and the 'prosecution' of developments are the stock-in-trade of local reporters and of the equally illiterate persons that play the mining 'game' on the frontiers of industry. The imitation of them should be beneath an educated engineer.

Young men, when about to describe a mine or explain a metallurgical process, are prone to start with the idea that they must indulge in 'fine' writing: meaning thereby a style pitched several tones higher than is habitual to them. When they prepare matter that is to be printed, they affect a vocabulary and a phraseology foreign to them; like the queer persons that have 'society' manners as distinguished from their behaviour at home. There are public occasions, of course, when an added dignity of bearing is befitting. For similar reasons, it is proper that the irresponsibility and ease of ordinary talk should give place to deliberate thoughtfulness when one is making a business statement or preparing matter for print; but the extra effort should not entail a pomposity that smothers the subject in verbiage. The attempt to write in a key higher than that of conversation need not provoke insincerity or affectation. It requires only more care and more deliberation. Write as if you were addressing an honoured senior in your own profession to whom you wished to convey information; do not try to impress him with your skill as a stylist, but make yourself perfectly clear, so that he may have the benefit of any facts or ideas that you can palce at his service. As a warning, I quote the following description of the Mount Morgan lode, in Australia:

(4) 'It may be considered as consisting of a network of veins, traversing on the one hand a metamorphic matrix of a somewhat argillo-arenaceous composition and on the other hand what appears to be a feldspathic tufaceous igneous rock.'

This is metamorphosed English pseudomorphic after flapdoodle. Much of the geologic description that poses as profundity is rhetorical rot. Similarly the technical terms needlessly used by half-educated writers remind one 'of the French that is spoken by those who do not speak French.'

A Tasmanian geologist described an ore deposit as due to 'the effects of a reduction in temperature of the hitherto liquified hydro-plutonic solutions, and their consequent regular precipitation. These ascended in the form of metallic superheated vapours which combined eventually with ebullient steam to form other aqueious solutions, causing geyser-like discharges at the surface, aided by subterranean and irrepressible pressure. What can you make of this 'geyser-like discharge' of language? You will find, if you take the trouble to translate the pretentious terms, that the description conveys a minimum of information with a maximum of sound: 'Full of sound and fury, signifying nothing;' or as Ruskin has said, 'Great part of the supposed scientific knowledge of the day is simply bad English, and vanishes the moment you translate it.'

Here is another sentence written by a young man who also mistook sound for sense:

(5) 'Since the installation of their air-compressor, a new campaign of development has been inaugurated, operations have been extensively prosecuted, more particularly in the carboniferous limestone, which is usually so prolific of values, due to the well recognized leaching of mineral solutions emanating from the plutonic magma.'

Many of these words are out of place: a bishop is installed, a president is inaugurated, a criminal is prosecuted, a rabbit is prolific. Incidentally, it may be noted that the water that leached the limestone probably came from above, not from below; originating in rain-fall, not from the depths. These grandiose words, being inappropriate, fail to convey a definite meaning; they only make a confusing noise. Probably he meant to say:

'The use of the new compressor has greatly expedited operations, particularly in the carboniferous limestone, which has been enriched by mineral solutions.'

This, however, is not satisfactory, because the sentence contains discrete ideas, wholly unrelated; therefore they should be separated, thus:

'The use of the new compressor has greatly expedited operations, particularly in the carboniferous limestone. This is important, because the limestone has been enriched by mineral solutions and therefore is a likely place to find ore.'

Samuel Johnson exclaimed: 'Witness the immense pomposity of sesquipedalian verbiage;' and we know how he himself sinned in that way. George Meredith, a master of words, recorded his objection to 'conversing in tokens not standard coin,' which is what 'prosecute,' 'install,' and 'prolific' are in such a context; they are not legal tender in the forum of technology; they are like Canadian quarters, British shillings, or French francs tendered to a merchant at Chicago or Denver, legal though they be at Montreal, Manchester, or Marseilles. As you know, I hold that the use of words of Latin origin, usually of more than one syllable, is helpful, if not indeed unavoidable in expressing ideas current in technology, but writing becomes incoherent when words are used because of their sound rather than their sense. Such usage bespeaks a snobbishness of mind, the aping of erudition, a mere pretence. If a man knows what a thing really is, he describes it as black or white; if he does not know what it is, he masks his ignorance by saying in long words that it partakes of the general quality of greyness. The young writers that clothe meagre observation in elaborate words soon fall into the habit of using terms that they do not understand, and therefore fail to make themselves understood, if indeed they do not convey information that is positively false. The employment of words that are unfamiliar to the writer, and that therefore are inconsistent with his own way of saying things, serves but to cripple his power of expression. He may get into a tangle by dragging strange words from afar. When he does find himself thus entangled he should cut loose, stating things in his own way, that is, in plain words that he understands thoroughly. Again I say: REMEMBER THE READER. If you do, you will win respect as a writer. The man with only a smattering of his subject splashes all over it with words of learned sound and unlearned meaning, because the ability to make such a noise is more easily acquired than the reality of knowledge. Huxley said that if a man really knows his subject, "he will be able to speak of it in an easy language and with the completeness of conviction with which he talks of an every-day matter. If he does not, he will be afraid to wander beyond the limits of the technical phraseology which he has got up." In his lectures to working-men Huxley showed how the fundamental truths of science could be stated in the simplest and most illuminating speech, without loss of accuracy. Indeed, the ability to explain scientific or technical matters to the unlearned is a test of the thoroughness of a teacher's understanding of his subject. If, for example, you care to test your grasp of engineering or geology, try to impart what you know to a younger brother or sister. That is a good test of your understanding and of your use of language."—T. A. RICKARD.—*Mining and Scientific Press*, Feb. 8, 1919, pp. 183/4/5. (H. R. A.)

Abstracts of Patent Applications.

561.18. Nitrogen Products and Carbide Co., Ltd. Improvements in or relating to the destructive distillation of carbonaceous material to increase the aromatic by-products thereof. 11.9.18.

This specification describes the destructive distillation of coal and carbonaceous substances within a tapered vertical retort, through which retort a mixture of stripped gas (gas that has been stripped of its condensible constituents) and acetylene (the mixture varying from $2\frac{1}{2}\%$ to 10% of acetylene, depending on the temperature to which the retort is heated and speed of passing the gas), is led, by means of pipes, into the lower end of the retort, passing through the red-hot coke, where the acetylene becomes polymerised into benzol and other hydro-carbons of the aromatic series, and is finally drawn off by gas outlets at the top of the retort. By this process it is claimed that a final tar product is obtained in which the benzoloid content is increased.

721.18. Labouchere & Co. An improved process for the separation of diamonds from diamondiferous matter. 27.11.18.

In this application the applicant claims to effect the separation of diamonds from the minerals with which they are associated after the ground in which they are contained has first been reduced to a certain size by mechanical crushing, or other means. The process is based on the principle that the diamond will withstand a greater pressure than the constituent parts of the rock in which it is found, provided such pressure is gradually applied and increased until the maximum pressure required to crush the material, with the exception of the diamond, has been attained the diamond being subsequently recovered from the residue by a sifting process.

267.19. Robert Forsyth. Improved process for and apparatus for grinding or pulverising ores, clinker, or the like. 15.4.19.

The apparatus consists of rollers of various designs, and the process claims are for a machine which is said to incorporate a new principle, in that the material treated as it is crushed between the co-operating rolls, is ground into the surface of the soft metal of which the rolls are formed, by the rubbing of one roll upon the other, due to their difference in circumferential speeds. It is claimed that the embedded dust particles thus distributed on the surface of the rolls, form a skin of tough material which protects the metal of the roll tyres, forming a superior grinding and abrading medium for the successful performance of the pulverising operation.

282.19. F. E. Elmore. Improvements in process for extraction of lead and zinc from their ores. 17.4.19.

This application deals with a process of separating lead and zinc from lead-zinc sulphide ore or concentrate. It consists in heating the material to be treated with strong hydrochloric acid, converting the lead into lead chloride. The mixture is then cooled and the excess acid and soluble impurities washed out with cold water. The lead chloride is next dissolved and washed out by means of a brine containing a small amount of lead chloride. The lead chloride is recovered by crystallization. Hydrochloric acid is regenerated by treating the lead chloride with sulphuric acid. A certain amount of lead chloride is kept and re-used in the brine circuit for dissolving the lead chloride from the acid treated mass. The sulphuric acid used may be generated from the sulphuretted hydrogen gas evolved during acid treatment of the sulphide ore or concentrate.

299.19. N. Z. Robertson (1), and H. Moss (2). Device for lowering and lifting winch drills. 23.4.19.

This application refers to:—(1) In combination with a rock drill support and a rock drill adjustable up and down the same; a device for lifting and lowering the rock drill comprising a tension member supported from above; a lever having means for supporting the rock drill, and means arranged either side of said supporting means, adapted to be alternately engaged with the tension member. (2) Apparatus as claimed in claim (1), in which the tension member is a chain into which the engaging members of the lever are hooked.

305.19. F. E. Elmore. Improvements in process for the extracting of lead from its ores. 24.4.19.

This application relates to improvements in the process of extracting lead from its ores by means of hot brine, with or without the addition of sulphuric acid, which consists in eliminating the deleterious accumulation of sodium sulphate from the used brine after removal of the lead salts by further cooling the liquor to 0°C; separating the crystals from the brine and dissolving in hot water, and then using this solution to convert the lead chloride present in the lead salts into sulphate. The claims consist of various modifications of the operations, and also provide for the recovery of any silver contents.

British Patent No. 6546/16, by the same applicant, is referred to as a type on which the above is an improvement.

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AN UNUSUAL PROCESS IN THE TREATMENT OF GOLD ORE.

By B. L. Gardiner, B.Sc. (Associate).

It is proposed in this communication to give a few notes on a method of treatment now being employed at the Connemara Mine in Southern Rhodesia, but before entering into further detail it may be as well to explain that the following is not an endeavour to give anything like a complete metallurgical record, but is more to set forth the essential principles involved in a process not commonly applied to the reduction of gold from its ores. The process, which, for the sake of a better name, has been termed the "baking process," consists merely in subjecting the ore to the action of heat preparatory to treatment by cyanide solutions. It differs from the ordinary "roasting process" in that the degree of temperature to which the ore is raised is much lower than that necessary for the roasting, and further that the presence of air or oxygen is in no way essential to its success, the application of a certain amount of heat being all that is needed. The net result of the introduction of the baking system at the Connemara Mine has been to increase the extraction from 68% to 86%, with little or no increase in the working costs.

Before going into any further detail as regards the process itself, it will perhaps be advisable to give some idea of the nature of the ore that is being dealt with, both as regards its physical properties and its behaviour metallurgically under the ordinary application of milling, amalgamating and cyaniding.

The ore of the Connemara Mine belongs to the class known in Rhodesia as Banded Ironstones, and at present only the upper oxidised portions of the lodes are being worked, and it is solely with this oxidised ore that this paper treats.

The liberty is taken of quoting some extracts from a petrological report by M. Weber, which indicate the more important minerals present and also the nature of the occurrence of the gold. The italics are the writer's, and the apparent intimate association of the visible gold with the hydrated iron oxides, as reported by the petrologist, is an important point, since it confirms conclusions derived independently by metallurgical deduction, as will be seen later.

"*C.A. Rich Ore 185 ft. N. 1st Level E. Reef.* Oxidised Banded Ironstone.

"A fine-grained mosaic of quartz grains, contains large quantities of iron oxides *and some iron hydroxides*, which have penetrated every fracture of the rock. Portions of the rock consist of secondary quartz infiltrations. These quartz veins have been fractured, granulated and invaded by iron oxides to such an extent that it is often not possible to distinguish them from the original rock material.

"Minute gold grains were also found in some iron oxides within the rock material."

"*C.C. No. 1 Level E. Reef Drive 100 ft.-150 ft.* Oxidised Banded Ironstone.

"A fine-grained rock consisting of alternating layers of iron oxides and granulated quartz. The section shows a series of fractures running almost normal to the bedding plane. Younger than these quartz filled fractures, is a contorted band of *hydrated iron oxides* which contain some grains and groups of grains of gold. *The gold occurs either in or on the contorted line*, which appears to have been one of the channels which collected and admitted the solutions from which the secondary gold has been precipitated."

Besides the silica and iron oxides which make up the bulk of the ore, qualitative analysis shows the presence of combined water, magnesia, sulphates.

In the upper parts of the lodes, crystals of magnesium sulphate are occasionally to be seen growing on exposed faces. In the lower portions, near or on the contact with the sulphide ore, crystals of ferrous sulphate are common, and also the various stages of oxidation to ferric sulphates.

The original plant consisted of twenty 1250lb. gravity stamps, and one 5ft. Chilian Mill as crushing units, followed by sand leaching and slime decantation plants, the gold being recovered by amalgamation on copper plates and by zinc shaving precipitation of the cyanide solutions. Ultimately it was found that the best commercial results were obtained by using 200 screening on the mill (aperture 0·0566 inches). The average results over a period of 12 months is given here, the tonnage varying between 4,000 and 4,600 tons per month.

Average value of the milled ore ... (Screen sample.)	6·76 dwt.	
Average value of mill tail ... ... (Calculated from values of sand and slime.)	5·87 dwt.	
Extraction by amalgamation	0·89 dwt.	13·2%
The pulp consisted of ... . . Slime = 33%		
Sand = 67%		
Average value of sand charges ...	6·07 dwt.	
Average value of sand residues ...	2·30 dwt.	
Extraction on sand	3·77 dwt.	62·1%
Average value of slime charges ..	5·47 dwt.	
Average value of slime residues ...	1·90 dwt.	
Extraction on slime	3·57 dwt.	65·3%
The total extraction on the whole treatment working out to		67·9%

The gold recovered over the same period gave a small surplus over the total gold called for. Such a poor extraction (barely more than two-thirds of the gold contained in the ore) could not be looked upon as very satisfactory and experimental work has been constantly carried on with a view to devising some possible working process whereby improvement might be brought about.

Retreatment of residues failed to recover any more gold, and laboratory tests, on the whole, merely tended to show that the plant was doing all that could be expected of it. It was certainly an unusual state of affairs for a completely oxidised ore such as that being treated to fail to yield a much greater proportion of its gold than that indicated by the results given. The gold in the ore is very finely divided, and by panning a crushed sample of ore worth 7 dwt. by assay a "prospect" of about 1 dwt. only is visible, and that very fine gold. In practice it was found, as stated, that a 200 screen (0·0566 aperture) gave the best commercial results, finer comminution than this leading to a very small additional extraction only, a circumstance which may be explained by the fact that the distribution of the gold in the sand is in greater proportions in the "fine," as is shown in the following sizing analysis of a sand charge.

Chg. 101.	6 7 dwts.	(400 screen on Mills.)
+ 40	9·0%	3·2 dwt.
− 40 + 60	21·1	4·2 dwt.
− 60 + 100	21·6	4·3 dwt
− 100	18·0	10·0 dwt
	99·7	6·9 dwt.

The coarser sizes show more silica, and the finer more iron oxides. A sizing of sand residue illustrates that the unrecovered gold is also mainly in the finest particles

Res. 160, 300 Screen on Mills.

Assay of charge ... ... 9·6 dwt.
Assay of residue ... ... 3·0 dwt.
Extraction 68·7%.

+ 40	26·3	2·3 dwt.
− 40 + 60	18·4	2·6 dwt.
− 60 + 100	17·8	3·6 dwt.
− 100	37·3	4·3 dwt.
	99·8	3·3 dwt.

The cyanide practice presents little or no difficulties, the ore being completely oxidised and free from any reducing or oxygen absorbing compounds, the occurrence of ferrous sulphate already mentioned being very restricted and not having any noticeable effect. Without the addition of lime, there is excessive consumption of cyanide, and this has been attributed to the action of ferric sulphate or basic iron sulphates, which may be expressed in a general way by the equation—

$$Fe_2\ (SO_4)_3 + 6KCN + 6H_2O$$
$$= 6HCN + 2Fe\ (HO)_3 + 3K_2SO_4.$$

By the addition of sufficient lime the abnormal destruction is arrested, and the cyanide consumption reduced in practice to ½lb. of NaCN per ton for the sand treatment, and 1lb. per ton for the slime.

The consumption of lime is high, being from six to eight lb. per ton of CaO.

The working solutions of the cyanide plant are singularly pure. Qualitative analysis indicating besides the cyanide and lime, zinc salts and traces of sulphates. Ferrocyanides and sulphocyanides are conspicuously absent.

Precipitation is good, provided that the sand solutions are maintained at 0·06% KCN and the slime solutions at 0·05% KCN, the latter condition making the consumption for the slime treatment higher than it might otherwise be.

These brief remarks will serve to show in a measure the nature of the ore. Many experiments had been conducted with a view to increasing the extraction, such as finer grinding, aeration, oxidisers, concentration, longer treatment, stronger solutions, preliminary acid washes, etc., but all failing to make any practical improvement. These and other tests dealing with re-treatment residues will not be recapitulated here, as it is proposed to explain the successful application of the baking process, but the foregoing remarks will serve to show the stubbornness of the ore to the application of the ordinary methods of treatment. A further peculiarity of the ore is that rock from some parts of the mine yields better results than that from other parts, the extraction in some months being as low as 63% and in others as high as 72%, a condition of affairs which makes comparative test work doubly difficult, and this is the best explanation that can be offered for several inconsistencies that may disclose themselves in the records of experiment which will be tabulated later.

During one poor extraction month (62·9%) residues were going out higher than usual, and the possibility of reprecipitation in the ore presented itself, and as a sort of indirect test for this a sample of sand residue was roasted in the muffle furnace; this sand was re-treated with cyanide, giving the following remarkable result:—

Sand Chg. 175.

Original assay value ... 7·0 dwt.
Assay of residue ... ... 2·8 dwt.
(The sample taken.)

60% Extraction.

Test A.—The residue was roasted and then intermittently agitated in a bottle with cyanide solution over 48 hours, washed, dried and assayed again.

Assay of final residue, 0·5 dwt.
Total extraction on 7·0 dwt.
=92·8% Extraction.

It was incidentally observed that on roasting, the colour of the ore had changed from a dark earthy to the colour of red ochre, which was very significant, in view of the greatly altered nature of the ore. A series of tests were then initiated which will be given in the chronological order of their performance. They are, except where otherwise stated, bottle agitation tests, and are aimed at obtaining the maximum gold solubility figure for the ore under the various conditions. A ratio of 2 : 1 : : solution : ore was used, also excess of lime, and at least 48 hours' agitation. The test was then thoroughly washed with an excess of water and finally dried and assayed:

Tests on Sample B.

	Sand charge 186	Assay.	9·5 dwt.
	Chge.	Res.	Extra %
B.—Roasted in muffle with stirring	9·5	0·5	94·7
B_2.—Sand placed in a G. crucible covered and brought to red heat in coke furnace	9·5	0·5	94·7
B_3.—Sand placed in sample tin covered and baked over "Primus" stove	9·5	0·6	93·7

The actual residue obtained from this charge 186, in the sand plant was 3·5 dwt., or 63·1% extraction.

The logical deduction from the above test was that some vital change had taken place in the ore, by the application of heat and from the knowledge of the constituents of the ore, this could be two things—

(1) Decomposition of sulphates.
(2) Decomposition of hydrates.

and the fact, as illustrated in test B_3, that a temperature below red heat is all that is necessary, inclines one to the idea (2), as also does the change of colour, the latter being reasonably attributable to the formation of Fe_2O_3 from hydrated oxides of iron. After being baked, the ore, while hot, is quite black, and gradually changes to the red on cooling, a well-known characteristic of ferric oxide: Heated in a test tube, a well dried sample of the ore yields a relatively large quantity of water, which condenses freely on the cold part of the tube and visibly escapes as condensed steam from the open end.

Test C. gives some idea of the volatile proportion of the ore.

Taken:—

20 grams of ore crushed to – 60 mesh.
Ignited in muffle at red heat.
Weight after ignition 18·9 grams.
Loss 1·1 grams = 5·5%.
SO_3 determined on same sample, 0·17%.
CO_2 determined on same sample, trace.

Evidently the greater part of the loss is accounted for as H_2O.

Test D.—Sample of ore crushed to pass 1½in. aperture screen. Assay 8·0 dwt.

D_1 Crushed through 300 screen aperture (0·04 inches), agitated with cyanide solution—

Original value … … …	8·0 dwt.
Residue value … … …	3·4 dwt.
Extraction … … … …	57·5%.

D_2.—Sample placed in closed vessel provided with small holes for steam to escape and then allowed to remain in the escaping gases of a boiler flue for 12 hours; then removed and ore crushed through 300 screen and treated as in E.1.

Original value … … …	7·7 dwt.
Residue value … … …	0·8 dwt.
	89·7%

The temperature of the boiler flue in question lies between the melting point of solder (say 190°-200°C.) and the melting point of lead, 327°C.

Evidently the temperature necessary to bring about the required decomposition is somewhere between 200° and 327°, much less than that required to roast a sulphide ore. A sample of the ore baked in the boiler flue loses a further 2% on ignition and gives off more water, so it is apparently not necessary to completely drive off all the combined water in order to get good results.

Test D_3.—Sample of ore E crushed through 300 screen first and then baked in flue of boiler for 12 hours, then cyanided as in D_1 and D_2—

Original assay … …	7·2 dwt.
Residue assay … …	0·8 dwt.
Extracted … … …	6·4 = 88·8%

This test established a further fact, and that is that the baking is as satisfactory on ore as coarse as 1½in. aperture as it is with minus 0·04 inch aperture.

Test E.—Lumps of ore passing 2 inch ring and not passing one inch. The pieces baked by placing in flame of "Primus" stove till colour changed.

Crushed to – 40 mesh screen. Cyanided.

Original assay … … …	5·6 dwt.
Residue assay … … …	0·5 dwt.
Extracted … … … …	5·1 = 91%

Test F.—Similar sample to E. Baked in dish over Primus stove for half an hour. Crushed through 20 mesh sieve and cyanided.

Original assay … … …	6·2 dwt.
Residue assay … … …	0·9 dwt.
Extracted … … … …	5·3 = 85·5%

Test G.—General sample of ore as coming from rock-breaker station (large ore and fine mixed). Baked at temperature less than dull red for 15 minutes. Crushed through 300 battery screen and cyanided.

Original value … …	11·0 dwt.
Residue value … …	1·2 dwt.
Extraction … … …	9·8 = 89·1%

Tests E, F and G evidence that very good extractions can be obtained by baking large lumps of ore, and with by no means excessive or prolonged heating.

It was further apparent from some of these tests, which consist of direct cyanide treatment only, that preliminary amalgamation is not a necessity for good extractions, evidently the gold being sufficiently fine to dissolve in cyanide solutions in a reasonable time. As it had been demonstrated that the ore could be satisfactorily baked in regard to coarseness, further tests were now made with a view of determining with what degree of coarseness it could be satisfactorily cyanided.

Test H.—Ore crushed through screen containing three holes to the inch (0·25in. aperture). Baked at less than red heat for ½ hour. Four days intermittent agitation.

An extraction of 87·9 % was obtained; the sizing analysis of the charge and the residue are interesting, as they show that approximately the same percentage of extraction is obtained on all degrees of fineness.

Sizing analysis of ore before treatment:—

+ 10	mesh	54·5 %	8·0 dwt.
– 10 + 14	mesh	11·0 %	8·0 dwt.
– 14 + 40	mesh	13·2 %	11·0 dwt.
– 40 + 100	mesh	10·0 %	11·0 dwt.
– 100		11·3 %	13·0 dwt.
		100·0 %	9·26 dwt.

Sizing analysis after treatment:—

+ 10	mesh	58·2 %	1·0 dwt.
– 10 + 14	mesh	11·2 %	1·0 dwt.
– 14 + 40	mesh	12·0 %	1·3 dwt.
– 40 + 100	mesh	7·5 %	1·3 dwt.
– 100		11·0 %	1·6 dwt.
		99·9 %	1·12 dwt.

It was eventually decided to erect a plant suitable for treating ore on a working scale, and for this purpose a rotary drier was installed, the following being a short description of the arrangements.

Drier consists of a tubular shell of ⅜in. boiler plate, 32ft. long and 5ft. diameter, made in five sections and set at an inclination of 1ft. in 16ft., or a total fall of two feet over its whole length. The shell revolves about its central axis and is supported on six rollers, the turning action being communicated through a large spur wheel round the periphery of the tube,, and is arranged to make one revolution in 45 seconds. The feed is led in through a 6in. pipe at the higher end and gradually travels down to the lower end, where the fire-box is situated, and is there discharged into a small hopper provided with a discharge door. The interior of the drier is divided by means of steel plates set radially into four sectors for the first 18ft. of its length, and the last 12ft. is lined with fire brick at the end nearest the fire-box. The fire-box in which wood fuel is burnt has a grate area of 21 square feet. The tube at the far end from the fire enters a brick dust settling chamber, which finally leads to a smoke stack, the whole arrangement being such that the ore travels counter current to the hot gases from the fire. The baked ore is transported from the dryer in trucks and dumped directly into sand vats for treatment. The possible charring effect of the hot ore on the filter bottoms and of damage to the tanks is overcome by covering the bottom with an inch or two of solution before dumping, and then, as the quantity of ore increases, by pumping in more solution so as to keep the hot ore from direct contact with the tank. In this way the dusting that results from the dropping of hot ore into the solution is kept at a minimum as each succeeding truck load is dumped on to the apex of the cone of ore in the tank and only a little at a time slides quietly into the standing solution.

At the outset of practical operations, it was decided to use 10 stamps to reduce the ore to sufficient fineness to be suitable for feeding to the drier, the ore to be classified into sand and slime and the sand only to be baked.

This was done, and several trial runs were made, with the stamps crushing through ¼in. aperture screens and the coarse sand then baked and cyanided. The extraction results were fair, ranging from 77·4 % to 85 %, but the "duty" of the drier was found to be small under such conditions, owing to the moisture carried by the sand. It seemed to take more heat to drive off the moisture than to raise the ore to the necessary temperature, and on the whole could not be termed an entire success.

Concurrently with the tests on the working scale, laboratory experiments were being further conducted to determine the extreme limit of coarseness to which successful cyaniding might be applied. Since the inception of ordinary milling operations, it had been the practice at the mine to separate out the fine by passing the ore as it leaves the rock-breaker, over a shaking screen, provided with screening of 1½in. aperture. This fine it was customary to feed directly to the chilian mill. Experimental work with this minus 1½in. product gave extraction results averaging 85 %, and it was therefore decided to cut out the chilian mill and feed the whole of the fine to the drier and then directly cyanide without further comminution.

The scheme was immediately put into practice. At first results were very varied, but control and test investigations soon showed that the fault lay with insufficient time of treatment in the cyanide, and steps were taken to provide more vat capacity. This done, the residues fell to a uniformly lower figure, and by close attention to details an average extraction of over 86% has finally been obtained.

So far only the fine, eliminated after the rock-breaker, has been subjected to baking, the balance of the ore going through the ordinary process of milling, amalgamating and cyaniding of sand and slime.

A peculiar feature in the nature of the ore is that the fine is much higher in gold contents than the "coarse," and the sizing brought about by passing over the shaking screen causes a considerable amount of concentration.

A practical example is the best illustration. During the months June, July and August, 1918, 12,047 tons of ore, valued at 5·77 dwt., were raised from the mine and treated. After passing the screen (1½in. lineal aperture), two products, the fine ore and the coarse ore, were made in the following quantities and values:—

Fine ore—
4,337 tons of 8·57 dwt. = 1,858·2 oz.

Coarse ore—
7,710 tons of 4·23 dwt. = 1,631·2 oz.

Total 12,047 tons of 5·77 dwt. = 3,478·8 oz.

Thus, it will be seen that the fine ore which amounts to little more than one-third of the whole tonnage, contains more than one-half the total gold contents.

A description of the whole treatment of the fine ore will not now be out of place. After the separation on the shaking screen the ore is led into a storage bin, whence it is fed into the drier via the feed pipe at an even rate, and gradually travels down to the discharge end, the time occupied in traversing the full length being estimated at about 30 minutes. The ore gradually takes up heat and by the time it falls into the discharge hopper, it is sufficiently baked for the subsequent treatment. It now presents a soot-black appearance, and is usually accompanied by a crackling noise as the result of numerous small explosions, which may be due to unequal strains caused through the heat, or, what is more likely, to the sudden eruption of imprisoned steam. Periodically, the hopper is emptied into trucks and transferred to the cyanide treatment tanks, slacked lime being added regularly to each truck. On cooling, the ore turns to a bright red colour, characteristic of ferric oxide, Fe_2O_3.

During the filling, strong cyanide solution (0·17) is pumped on as needed to keep the hot ore from direct contact with the tanks, finally covering when a charge is levelled off. Contact takes place for twelve hours, and then the whole charge is drained off, and another strong solution pumped on. Subsequent treatment consists of pumping on washes of 0·6% (sump) solution, giving alternate contact and draining. It is important to drain out completely every charge of solution, as residue assays show that more rapid and better extractions are obtained in this way than by continuous percolation.

The time of treatment averages 10 days, and the total quantity of solution in tons is at least 1¼ times the tons of ore treated.

No difficulties are met with in the cyanide plant, other than the high consumption of lime, which is rather greater than that consumed by the unbaked ore, amounting to 10-12lb. per ton in terms of pure CaO.

A sizing of a sample of fine will give some idea of the material being treated.

Baked Ore.

Sample of Residue		*1·6 dwt.*
+ ½in. mesh	26·9%	1·2 dwt.
− ½in. + ¼in. mesh	14·9%	1·6 dwt.
− ¼ + 10 mesh	31·3%	1·6 dwt.
− 10 mesh	26·9%	1·6 dwt.
	100·0%	1·49 dwt.

In mass it has the appearance of rather coarse gravel, some of the lumps being as large as walnuts and then all sizes, as the above test shows. With such material, there is, of course, not the slightest difficulty in obtaining good percolation.

The treatment figures on the baked ore for the three months June-August, 1918, are here given.

CONNEMARA MINE.—BAKED ORE TREATMENT.

MONTH.	FINE ORE BEFORE BAKING.		FINE ORE AFTER BAKING.			RESIDUES.		Gold called for.
	*Tons.	*Assay dwt.	Tons.	Assay dwt.	Gold contents oz.	Assay dwt.	Gold contents.	Oz.
June ...	1,317	7·6	1,252	8·0	506·0	1·0	67·6	438·4
July ...	1,460	8·2	1,387	8·7	603 9	1·09	76·1	527·8
August ...	1,560	9·5	1,482	10·0	748·3	1·49	110·5	637.8
	4,337	8 57	4,121	9 01	1,858·2	1·23	254·2	1,604·0

*Obtained by calculation allowing 5% loss in baking. Theoretical extraction, 86 3%.

It has not been convenient to keep the gold won from the baked ore separate from the gold won by cyanide from other sources, but over the whole period the total gold won tallies very closely with the theoretical call, and it is a fair assumption that the gold yield confirms the assay figures given above. The actual call and recoveries for the three months were:—

	Gold called for.	Gold recovered.
June	919·6 oz.	861·8 oz.
July	837·5 oz.	862·1 oz.
August	742·0 oz.	750·5 oz.
Totals	2,499·1 oz.	2,474·4 oz.

Costs.—On the Connemara Mine it has not been the practice to keep segregated costs, but a liberal estimate of the average expenditure works out at about 1s. 10d. per ton, for the actual roasting and including transport to and from the drier to about 2s. 2d. per ton.

The principal item is fuel, from five to six cords a day being consumed when running, and amounting to 1s. 3d. per ton baked. Power is estimated at 3 to 4 h.p.

Other items, European and native labour, oils, repairs and renewals making up the balance.

With a plant designed and arranged specifically on the baking lines, no doubt costs could be very considerably reduced.

The heat efficiency could be greatly increased also by lengthening the dryer, with a consequent reduction in the fuel bill. Such improvements in this instance have been so far limited by financial considerations, for they would mean re-modelling a large section of the existing plant. As things are, the baking does not cost more than the chilian mill, which it supplanted, and so the improved extraction amounts to so much net gain to the working profit.

Proposals have been made for treating the whole of the ore by baking and several different schemes offer themselves for consideration. One of them is to bake the large ore first, and then to crush in the stamp mills, preparatory to cyaniding. An experimental furnace built on the lines of an outside fired lime kiln has been erected, the hot gases from the fire being made to pass up through the broken rock. As it becomes baked the ore is drawn off from the bottom, while more ore is fed in at the top, the furnace or kiln thus being continuous in action. So far, only short trial runs have been made, but they proved that the ore could be baked well, and laboratory tests have given improved extractions. Two reasons, however, have precluded the continuation of this scheme for the present. One is, that on a grade of 4 dwt., the extra extraction obtained by baking does not mean so much in hard cash, and the probable margin over the cost of baking which is here an extra charge, is consequently small. The other is, that difficulties with the fuel supply render it advisable to conserve wood as much as possible.

In finally discussing the metallurgical side of the process, some explanation is called for to account for the greatly improved extractions obtained after the ore has been subjected to the application of a moderate degree of heat.

It has been pointed out earlier in this communication that the ore contains considerable proportions of hydrated oxides of iron and that, when heated, appreciable quantities of water are given off. This water, it must be understood, is not present as moisture, since it will not be driven off in a water bath at 100°C., but requires a somewhat higher temperature, and it is evident that it exists in the ore as water of combination.

The petrological report already quoted shows that the gold exists closely associated with the hydrated oxides, and no doubt much of the gold is due to secondary deposition, as the oxidised portion of the ore body is markedly higher in value than the sulphide portion, the latter, in fact, being unprofitable to work.

Be the origin of the gold what it may, there is no doubt that it is coated or locked in some way so as to be inaccessible to cyanide solutions, and the most likely substances among the constituents of the ore to bring about such a condition are the hydrated iron oxides.

In all the old dumps of sulphide ore lying on the surface can be seen the peculiar cementing action of these secondary products from iron sulphides, caused through the ordinary weathering by atmospheric agencies. On digging into these dumps, not more than five to six years old, large masses can already be found bound together by the cementing action of the hydrated oxides, individual lumps appearing as if glazed over with some rusty coloured varnish. It is well known, of course, that if limonite and minerals of similar constitution are heated sufficiently, they will yield up the water and remain as ferric oxide (Fe_2O_3) in the form of a very fine and porous powder; in fact in an ideal form for cyanide solutions to penetrate and leach out any gold which may be commixed. Such action as this is doubtless what takes place in the ore when it is baked, and the theory readily explains the improved extractability of the ore. That the gold can be dissolved out of such large pieces as are now actually being treated depends also to a great extent on the increased porosity of the ore caused by the dehydration, but it is assisted greatly by the structure of the ore.

In hand specimens the appearance does not by any means give the impression of any great porosity; if anything, the reverse; but the rock sections apparently show that it is much crushed and contains numerous minute channels for the most part filled with hydrated oxides of iron.

A simple test which shows the porosity of the ore is the following. If a piece of baked ore, say, as large as a man's fist, is baked and then, after cooling, is placed in a vessel of water, minute bubbles can be seen rising from it, much the same as those seen when an ordinary red brick is immersed. If, after standing a minute or two, the piece is removed and broken up, it will be found that the interior is wet all through, which shows that water can penetrate to every part of it, and practical results have shown that cyanide solutions, given sufficient time, can dissolve out a large proportion of the gold contents. The one other feature that calls for special remark is, the fact that the coarse, or what is better termed in this case, the visible gold, does not seem to hinder the cyanide extraction to any known extent. In the ordinary treatment some 13% of the gold is recoverable by amalgamation, but in the baking treatment all this is recovered by cyanide.

A special test was made by collecting some of the free gold by panning and transferring to a glass beaker with 0·25% cyanide solution. The beaker was shaken up at irregular intervals, only during the day, and allowed to stand over night, and on the fourth day all the gold had disappeared into solution. It must be admitted, however, that all the visible gold is very fine, much finer in fact than that usually met with. The foregoing covers the principal points in connection with the baking process as now being conducted at the Connemara Mine; the actual details of the work may not yield the maximum results from a purely metallurgical point of view, but from the commercial aspect of yield against cost, the practice pertaining there is probably not far wrong.

By fine dry crushing, roasting and cyaniding, there is every probability that extractions approaching 95% could be obtained, but at a greatly increased cost, and, conversely, it is quite within the bounds of possibility that a fairly high recovery might be gained by merely roasting all the ore as it leaves the rock-breaker (say, minus 3 inch ring), and subjecting to direct cyaniding. The latter scheme would be sure to require a very long treatment, and would mean a very large vat capacity ratio to the tonnage treated.

On the whole the existing scheme would appear to give about as good a profit as any other, when the capital cost of any alterations and additions is taken into consideration.

As a process likely to be applicable to the generality of gold ores, baking is not likely to hold a very important place, as its success depends on an unusual peculiarity. At the same time, there may be other ores of a similar nature, and with such as these the baking process may find a beneficial application.

Obituary.

Dr. Donald Macaulay, O.B.E., Lt.-Col., R.A.M.C.

The sudden death on the morning of January 28th of Dr. Donald Macaulay came as a great shock and sorrow to the very wide circle of those on the Rand, and elsewhere in South Africa, who had known and who loved him. The shock was deepened by the peculiarly tragic and distressing circumstances under which he died, alone, and at night, run over and pinned down by his own motor car.

Donald Macaulay will be remembered as a man who has left his mark alike on the life of this community and in other spheres into which his energy and enthusiasm carried him He was a Celt of the Celts. With a geniality, expansiveness and sociability which endeared him to everyone, and a ready, sparkling humour, expressing itself in a fund of story, wit and anecdote, which made his companionship a charm, he combined a keen, clean-cut, vigorous intelligence, great mental energy, and a quick imagination and enthusiasm. He had a brilliant, lovable, frank, and sympathetic personality. He made friends everywhere. I doubt whether he ever made an enemy.

Donald Macaulay was born in the Western Highlands of Scotland fifty-one years ago. Until his college days he was brought up in the Highlands, and his speech never lost the liquid intonation and charm of the northern tongue. From Inverness Academy he went to the University of Edinburgh, where he soon made a name for himself as a brilliant student, and where he is still remembered well. He took, first, the degree of Master of Arts, in the old days when the Arts curriculum was still a compendium of general culture. Then he passed on to the study of medicine, and graduated as Bachelor of Medicine and Master of Surgery towards the middle of the nineties. Perhaps this double training in part accounted for, in part expressed, the breadth and variety of his interests, which were never bounded wholly by the profession which he adopted. Afterwards he spent one or two "wander-years," which carried him, as ship's surgeon, as far as Japan. Ultimately, in 1897, he purchased a mine practice on the Rand, and came out to South Africa. He married Miss Margaret Mackenzie the day before he sailed, and she accompanied him to this country.

The practice which he had bought was at Cleveland, near Johannesburg. That district was his home for the remainder of his life; it was there that he died. His reputation as a brilliant man in his profession was soon established. His ability brought him many patients, his ready sympathy made them his friends.

Then came the Boer War, in which Dr. Macaulay served as civil surgeon with the Imperial forces, both on the hospital ship "*Dunera*" and in South Africa.

After the war he returned to Cleveland, and during the few years following he performed his first great service to the Rand. He was already recognised as one of the leading men in his profession. His interests were more medical than surgical. His practice lay on the mines, and his quick intelligence and sympathy drew his interest to the subject of the causes and the prevention of the peculiar dangers of the occupation of mining, particularly to the serious problem of miners' phthisis, to the question of the causation and nature of accidents from "gassing," and to the causes of sickness and mortality amongst native mine employes. Dr. Macaulay was one of the signatories to a report by a committee of the Transvaal Medical Society, which formed the basis of the first Report on Miners' Phthisis, issued in 1903. The subject, however, was far from being exhausted by that first report, which did not fully recognise the necessity for a wide variety and precision of preventive measures.

Dr. Macaulay returned to the problem, therefore, in 1905 and 1906, and the older members of the Society will well remember the crowded, interested, and animated meetings at which discussion ranged round the papers on "*Safety Measures in Mining*," read before the Chemical, Metallurgical and Mining Society by Dr. Macaulay, and his colleague, Dr. L. G. Irvine. The Society's gold medal was awarded to the writers in 1906. Other members also contributed papers bearing on the subject, and the Society may well feel proud of the full share which it has taken for many years in the investigation and ventilation of the miners' phthisis problem.

At this time also Dr. Macaulay drew attention to the danger of poisoning and death from nitrous fumes in gassing accidents in mines in two papers on "*Gassing by Dynamite Fumes*," published in the *Transvaal Medical Journal* for February and July, 1906. He was the first to publish locally cases which conclusively established the existence of this danger.

In 1908 Drs. Macaulay and Irvine presented to the Mining Regulations Commission a "*Statement on Conditions affecting the Health of Underground Workers on the Mines of the Witwatersrand*," which provided a good deal of the material upon which the recommendations of that Commission were based, both in regard to the prevention of miners' phthisis and of gassing accidents, and also in other directions. These recommendations have since been considerably supplemented and extended, mainly through the work of the Miners' Phthisis Prevention Committee, but it is safe to say that the serious, general, systematic and practical attempt to grapple fully with the miners' phthisis problem on the Rand really dates from the Report of the Mining Regulations Commission. And it is safe and just to say also, that to no one individual is more credit for the elucidation of this problem due than to Dr. Donald Macaulay; to no one individual do the miners on the Rand owe a greater meed of gratitude.

Political interests now claimed him, and, when the first Transvaal Legislative Assembly was elected, Dr. Macaulay was chosen as the representative of the mining constituency of Denver in the Unionist interest. He sat in the Transvaal Parliament until the Act of Union was passed in 1910, and afterwards represented, on the Unionist side, the constituency of Cleveland in the South African Parliament at Capetown. All of this meant a great break with medical work, and during this time he relinquished private practice, and accepted an appointment as medical officer in charge of the native employes of a group of mines in the Cleveland district. This appointment he held until his death. His political work kept him a good deal away from the Rand, and the local medical community was the loser by his absence. In Parliament Dr. Macaulay made many friends in every part of the House, and he continued to show his practical interest in the mining community by the advocacy of allotments for miners, and in other directions. But the subtle art and sometimes winding ways of politics were not perhaps his *métier*. The cast of his mind was intelligent, sympathetic and imaginative, rather than constructive. His true *métier* was medicine.

So, when the great war broke out, Dr. Macaulay applied at once to go on active service. A post suitable to his great professional capacity was found in the command of the South African hospital ship "*Ebani*." In that post he served during the campaign in German South-West Africa. At its conclusion he proceeded with his ship by the East Coast to the Mediterranean, and thence to England. He returned to German East Africa, and thereafter plied in the "*Ebani*" many times between German East Africa and the South African ports. Later he left the "*Ebani*" and took command of No. 3 General Hospital at Durban. That was the last of his long war services. At the conclusion of the war he received the distinction of an Officer of the Order of the British Empire.

He returned to the Rand during 1919, and within a few months suffered a terrible bereavement in the death by influenzal pneumonia of the wife who had been his devoted companion during many years of married life. He never recovered from the blow. He went to England for a few months to settle the affairs of his sons, and had been back upon the Rand only for a short time when he met his death. He leaves two sons, the elder of whom is studying medicine in Edinburgh, and the second is there also, at school. To them the deep sympathy of all who knew their father will go out. To them and to his friends he leaves the fresh memory of a gifted, brilliant, generous-hearted man, who rendered great service to his country, and to the community in which his lot was cast. His record is worthy of him, and he will be long remembered. L. G. I

FOURTH ANNUAL MINING EXHIBITION.

The fourth Mining Exhibition, organised by the Society was held in the Assembly Hall of the S.A. School of Mines and Technology from the 21st to the 31st January. It was not found possible to hold these Exhibitions during the war, and the lack of shipping facilities and other difficulties, including the impossibility of obtaining larger accommodation precluded the exhibition from being on as large a scale as those held previously. Consequently it was decided by the Exhibition Committee, Messrs. Jas. Gray (President), J. Chilton, H. S. Meyer, J. R. Thurlow, F. Wartenweiler and A. Whitby that this year, the Exhibition should be primarily for exhibiting the many devices and materials manufactured locally on or for the mines during the war as substitutes in place of supplies usually imported, together with other devices and apparatus used on the surface and underground, safety-first devices, mineral products, and diagrams, models, etc., of mines, works, plants, apparatus, etc., of recent date or connected with the early history of the Transvaal mines.

Whatever the exhibition lacked in size, in point of interest it compared most favourably with its predecessors, and the exhibits received filled all the space in the Assembly Hall.

The Exhibition was opened on Wednesday morning, the 21st January, in the presence of a large and representative gathering, by His Excellency the Viscount Buxton, G.C.M.G., the Governor-General of the Union.

The President of the Society and Chairman of the Exhibition Committee, Mr. Jas. Gray, F.I.C., in welcoming His Excellency, said that was the first official opportunity they had had of meeting the Honorary President of the Society, Lord Buxton, and he assured him that their welcome was no less cordial than that extended to him by other institutions he had honoured with his presence. The first mining exhibition was held in February, 1912, and its success was such that they were encouraged to hold them annually and did so up to 1914. The war, thereafter, prevented their continuance, and they were now resuming their former activities. He desired to convey the cordial thanks of the Society to the authorities of the School of Mines and Technology for their kindness in granting use of this hall. Many of the exhibits showed how South Africa met the shortage of supplies due to war conditions, and this was exemplified by the exhibits from the gold mining industry. Necessity was truly said to be the mother of invention, and the manner in which those who were called upon to meet the unsual conditions, rose to the occasion was, he thought, to be commended. (Applause.) The value of the manufactures of the Union in the year 1916-7 was £49,457,414, and the employes, white and coloured, numbered 123,842. The value of the mineral production in 1917 was £52,260,190, and there were 308,419 employes. These figures showed the important position which industries held and their value to the country. The potential industrial resources of South Africa had been the text of many remarks by political leaders within recent days, and to members of this and other technical societies this recognition was a matter for congratulation. They hoped, however, that when the political turmoil which would soon be raging, died down and the various parties had been adjusted by the electorate, that the Government would lend a sympathetic ear to the request of those desirous of developing industries which would tend to make South Africa less dependent on overseas importations than she had been in the past.

The Society in promoting the Exhibition felt that it brought home to the public in a manner which no number of blue books could do the vast possibilities which existed within the Union. (Applause.)

LORD BUXTON'S ADDRESS.

Lord Buxton, in opening the Exhibition, said :—I am very glad to be here for this movement is a practical one, and a many-sided one, and all the facets are good, for its object is to combine educational and humanitarian, as well as economic and industrial development. The Society under whose auspices we are met to-day is the Chemical, Metallurgical and Mining Society of South Africa, a clumsy, but descriptive, title. Its main object, as I understand, is to exchange ideas; to disseminate and spread scientific and technical knowledge. The Society was instituted as long ago as 1894. I am told it was the outcome of a supper, which clearly must have been of a light and wholesome character. It has had the inevitable vicissitudes due to the volcanic and eruptive disposition of this country. Much invaluable pioneer work has been done by the Society, especially in reference to the amelioration of underground conditions. The Society can be especially proud of one thing. It can justly claim, I believe, to have been the first to have given attention to that scourge of the industry, miners' phthisis, and has done much in various ways for the amelioration of that terrible disease by proposals for improved ventilation, the determination of injurious dust particles, the allaying of dust, and the elimination of injurious fumes. It must be admitted, I fear, that in earlier days there was undoubted neglect in these matters; more, I think, from want of thought than from want of heart. Knowledge was amateurish, the conditions of the industry and its attendant dangers were not realised or understood, and the application of remedies was slow and faulty. But that period is long past, and of late years a different spirit has prevailed, and, coincident with an increasing desire on the part of employers and others to do what could be done for the well-being of the employes, whether whites or natives, medicine and science have come to their aid, and care and research have been effectively applied. The greater care and greater interest shown has also, I believe, helped to improve the relations between the employers and the workmen.

The Society in this and in other ways has advocated and assisted in what is called "Safety First," the safety and welfare of those working underground and elsewhere, to reduce the liability to accidents, and to improve the surrounding conditions. One side line of its activities in this respect has been its effective co-operation in the creation of the S.A. Red Cross Society for First Aid and Ambulance work. In this connection the community is deeply indebted to Mr. Fred Rowland, the Secretary of this Society, for the great work he has done while Hon. Secretary of the Red Cross Society.

Now that he has had to give up the hon. secretaryship he has left the Society in a good condition, and I am sure that in future it will benefit by his advice and assistance. (Applause.)

My special duty to-day is to open this Exhibition, the fourth of its kind. Exhibitions were held in 1912, 1913 and 1914, when the war intervened; and it is now thought that the time has again come when an exhibition can be advantageously held. Its main objects are to bring to the notice of those interested in the mining industry, and to the public generally, the many ingenious devices of inventors, and ocular proof of the natural products of the country, etc. The Exhibition, it is hoped, will encourage and stimulate inventive capacity in those who have an opportunity of studying the working in mines and elsewhere, either for safety or for economy of working, which often go together. It is especially an encouragement to "small men." Indeed it may be called a small men's exhibition; and it is often from the small man working at the industry that the big invention has come—Watt, Arkwright, etc. To these it gives an opportunity, which they would not otherwise have, of showing what they can do, and assisting them to work out their ideas. Inventors are somewhat difficult people to deal with, as I know by painful experience at the Board of Trade and at the Post Office in England. If the invention is not at once adopted the inventor so often imagines that the powers that be are in league against him—a quite unfounded suspicion. Here at least the invention, if it is worth anything, can be practically considered and examined; and at all events the suspicion that it is ignored and suppressed without consideration would disappear.

One object of the Exhibition is no doubt to pick brains. But it also gives to those whose brains are picked an opportunity of benefiting from their own grey matter. Then, again, the owners of mineralised ground and others will have a good opportunity of showing what minerals and raw products are to be found in the country. One of the Inspectors of Mines in his report for 1917 shows that the surface of the country has as yet been barely scratched. But much more is needed than mere scratching. It is no good merely asserting, or even showing, that there are minerals unless the ore is properly developed, and the resultant product shown to be equal to the samples. All this requires hard work, industry, intelligence and scientific and technical application. South Africa is still in its infancy. It needs population, capital, industries, increased production from agriculture and from existing industries, and the opening up of new industries. Arthur Young, the economist, once said that he who produced two blades of grass where only one grew before, was a public benefactor. Still more can it be said that he who, by any invention saves two lives where only one was saved before, is a public benefactor; and he who by invention doubles the production of some useful mineral benefits the community. It appears to me sometimes that the tendency in this country to rely on Government aid is rather too pronounced. It is a very good thing that the Government should be interested in, and encourage, all improvements, humanitarian, industrial and economic; but, what is even more important, is that initiative and self-reliance should not be weakened by over dependence on Government.

The past history of this country is a great example of what can be done without Government assistance, and by self-reliance, courage, and enterprise. This Society and Exhibition will do much to help South Africa towards the development of existing and of new industries. (Applause.)

His Excellency then declared the Exhibition duly opened.

Sir Evelyn Wallers (President of the Transvaal Chamber of Mines), in thanking His Excellency for his attendance, voiced the general regret of the community that the time was approaching when their Excellencies would be leaving South Africa. They had established a place in our hearts that was given to few. (Applause.)

His Excellency then inspected the exhibits.

The organisation and secretarial arrangements of the Exhibition were efficiently carried out by the Society's Secretary, Mr. Fred Rowland, O.B.E.

The Exhibition was open daily, except Sunday, from 10 a.m. to 10 p.m., free of charge, and during the whole period it was open, there was a constant stream of interested visitors. It is estimated that from 10,000 to 12,000 people passed through the doors.

The Exhibition Committee acknowledges with much appreciation the fact that the Chamber of Mines guaranteed the Society against financial loss.

EXHIBITS BY MINES AND MINE EMPLOYEES.

1. Transvaal Chamber of Mines, Johannesburg:—(*a*) A collection of Jack Hammer Rigs, and other Rock Drills, etc., together with photographs and drawings of rock drilling machines. (*b*) Apparatus for illustrating to miners errors frequently made when drilling a cut.

2. Messrs. F. C. W. Ingle, J. R. Armstrong Kelly, and F. Lally, City and Suburban G.M. Co., Ltd.:—Mining Shovels with "Kelco" patent shovel points attached.

3. City and Suburban G.M. Co., Ltd.:—(*a*) Shaft Roller; piece of Faggotted Iron; 14lb. Hammer; 4lb. Hammer; 3lb. Hammer; Dog Spikes; piece of Drill Steel rolled from 1¼in. to ⅞in. (*b*) Underground Ventilation Door, adapted to allow for crushing from roof and sides. (*c*) Rotation Explosives Box.

4. City Deep, Ltd., Johannesburg:—Board with Tools, Spares, etc., made on the mine.

5. Mr W. Hoskings, Consolidated Langlaagte Mine: Patent Tubular Saw for joggling mine poles (average output 1,000 poles per day).

6. Consolidated Langlaagte Mines, Ltd., Langlaagte:—(*a*) Rock-drill Machine Chuck. (*b*) Steel and Tools made from discarded hoisting ropes. (*c*) Axial Water Feed Machine Feed Pole.

7. Consolidated Main Reef Mines and Estate, Ltd., Maraisburg:—(*a*) Model Truck Frame. (*b*) Thomson's Slime Sampler. (*c*) Mortar Box End Liner (patched). (*d*) Dies made from broken Cam, Shoe and Head. (*e*) Rock-drill Cylinder Protector. (*f*) Stephen's Tappet Adjusting Clamp.

8. Mr. W. Hawke, Crown Mines, Ltd:—(*a*) Mercury Bottle as used in Reduction Works. (*b*) Oil Bottle as used underground. (*c*) Method of welding hollow drill steel, showing five pieces.

9. Mr. H. Minnaar, "C" Mill, Crown Mines, Ltd:—An improved Challenge feeder lever or Friction Ratchet for mill feeder table.

10. Crown Mines, Ltd. :—Complete set of internal parts (locally made) of High Lift Centrifugal Mine Pump.

11. Mr. F. W. Cindel, Durban Roodepoort Deep, Ltd., Roodepoort :—Two Cam Shaft Collars with Wedge and Drift for tightening and loosening same.

12. Mr. S. H. C. Munro (Exner St., Roodepoort), Durban Roodepoort Deep, Ltd. :—Automatic Water Blast.

13. East Rand Proprietary Mines, Ltd., East Rand :—Board containing articles and materials made on the mine through lack of imported material.

14. Ferreira Deep, Ltd., Johannesburg :—(*a*) Locally made Shoes and Dies. (*b*) Repaired Battery Cam. (*c*) Machine Rock-drill Column Heads made from broken Heads of Battery Stems. (*d*) Hand Jumper with Read Pear Head. (*e*) Hollow Steel Welding Process. (*f*) Electric Drying Plate and Sample Dryer. (*g*) Weaver Candle Holder.

15. Francois Cementation Syndicate, Corner House, Johannesburg :—Models and Apparatus of the Francois Cementation Process.

16. Geduld Proprietary Mines, Ltd., P.O. Dersley :—(*a*) One pair 12in. C.I. Truck Wheels and Axles. (*b*) Board with Truck Greaser; Rope Roller; Rope Jockey; Turbine Blade; Dog Spike.

17. Geldenhuis Deep, Ltd., Cleveland :—Whitford Atomizer, Model and Blue Print.

18. Mr. Ralph Hush, Geldenhuis Deep, Ltd., Cleveland :—(*a*) Blue Print of Adjustable Bracket for Sorting Table Carrier Wheels. (*b*) Planetary Joint for Friction Clutch Arms (connecting rods) or such like appliances. (*c*) Ring Bender for curling oil rings used in self-lubricating bearings. (*d*) The Hush Pulverizer for Assay Office use.

19. Knight Central, Ltd., Germiston :—Clamp for fastening the end of broken rails.

20. Modder "B" G.M. Co., Ltd., Benoni :—Board of Sundry Fittings.

21. Mr. W. Parr, New Kleinfontein Co., Ltd., Benoni :—The Parr Water Blast.

22. Mr. H. L. Kendrick, New Kleinfontein Co., Ltd., Benoni :—Model of Improved Ventilation Door for use underground.

23. Nourse Mines, Ltd., Denver :—Collection of Rock-drill Spares made on the mine.

24. Mr. H. A. Read, Rand Mines, Ltd., Johannesburg :—Improved Hand Drills.

25. Robinson G.M. Co., Ltd., Johannesburg :—(On metal table made on the Mine): (*a*) High pressure By-pass Valve. (*b*) Two Patent Oil and Grease Feeders, one new and one which has been in use 14 months underground. (*c*) Patent Improved Plug Cock.

26. Mr. A. E. Jackson, Robinson G.M. Co., Ltd. :—Improved Splint Stretcher for Fractured Spine.

27. Mr. G. F. Piper (105, Kerk St.), Robinson Deep G.M. Co., Ltd. :—Automatic Lubricator for greasing plungers, pistons, packing, and the like.

28. Simmer and Jack Proprietary Mines, Ltd., Germiston :—(*a*) One Underground Reversing Winch, 4in. × 5¼in. (*b*) Collection of Rock-drill Spares. (*c*) Shaft Roller with Frame.

29. Mr. Jas. Macdonald, Simmer & Jack P.M., Ltd., Germiston :—One Coil of Wire Rope, ½in. diameter, 720 ft. long. Made from the strand cores of discarded, or compound stranded 1⅛in. diameter rope.

30. Sub-Nigel, Ltd., Nigel :—(*a*) Bucket made from old belting. (*b*) Safety Helmet (metal).

31. Village Deep, Ltd., Johannesburg :—(*a*) Shoes and Dies made on the mine. (*b*) Electric Soldering Iron. (*c*) Electric Metal Melting Pot. (*d*) Converted Rock-drill Piston. (*e*) Incline Shaft Rollers (mushroom type). (*f*) Drawing of Mine Safety Gates. (*g*) Drawing of Power Hammer.

32. Mr. Wm. Daly, Village Deep, Ltd. :—(*a*) Five Tappets mounted on stems and set in frame with iron guides complete. (*b*) Cam Shaft Collar.

33. Village Main Reef G.M. Co., Ltd., Johannesburg :—(*a*) Ancient Hammer Drill. (*b*) Board of Tools, etc., made on the mine. (*c*) Models of Wilson Pigsties. (*d*) Model of Smythe's Skip and Tipping arrangement. (*e*) Rail Clamp.

34. West Rand Consolidated Mines, Ltd., Krugersdorp :—Board with Tube-mill Liner Brick; Mill Die; Climax Chuck Bolt; Indian Machine Chuck.

35. Mr. W. Thomas, Wolhuter Gold Mines, Ltd., Johannesburg :—(*a*) Shovelling Chute made from old wire ropes. (*b*) Old Pipe lined with cement. (*c*) Simple Spray for Cooling Dam. (*d*) Blue Print of Machine for Driving Axles out of Truck Wheels.

36. Mr. D. Maclachlan, P.O. Box 6275, Johannesburg :—Self-locked Detachable Bit for Rock-drilling Machines.

37. Witwatersrand Co-operative Smelting Works, Ltd., Johannesburg :—Shoes, Dies, etc., made from scrap by an Induction Electric Steel-Melting Furnace, with a capacity of one ton every six hours.

38. Mr. Lionel Harris, Underground Officials' Association, Johannesburg :—An Automatic Konimeter (rough unfinished model). In its final form will take 144 samples at intervals of 10, 15, 20, 30, or 60 minutes by a simple adjustment.

39. Dust Sampling Committee, Transvaal Chamber of Mines :—Apparatus used in taking and testing samples of Dust underground, including Konimeters, Dust Pump, Sugar Testing Apparatus, etc.

40. Miners' Phthisis Medical Bureau (adjoining S.A. Institute of Medical Research), Johannesburg. Dr. W. Watkins Pitchford, Director :—X Rays as an aid to the Diagnosis and Study of Diseases of the Chest. (1) Radiogram of the Chest of a healthy person. (2) Radiogram of the Chest of a man who is beginning to develop Silicosis. (3) Radiogram of the Chest of a man with well marked Silicosis. (4) Radiogram of the Chest of a man with advanced Tuberculosis (Consumption) but without any Silicosis.

41. Major H. Standish Ball, O.B.E., R.E. :—Geophone as used on the Western Front for detecting sounds underground.

42. The Rand Pioneers, Johannesburg. Pictures and Photographs, etc., of :—(1) The First House built in Johannesburg. (2) The First Government Officials on the Rand. (3) The First Chemist's Shop in Johannesburg. (4) The Original Standard Bank in Johannesburg. (5) The beginning of the Eagle Mine. (6) The Rand Club in 1888 with some early members. (7) The Wemmer Mine and "Diggers' News" Printing Works in 1889.

43. Dr. W. A. Caldecott, Consolidated Gold Fields of S.A., Ltd., Johannesburg :—(*a*) Photograph of Mr. J. S. MacArthur, the discoverer of the Cyanide Process. (*b*) Photograph of the first plant by which the success of the Cyanide Process was demonstrated, Salisbury Mine, 1890.

14. Institute of Land Surveyors of the Transvaal, Johannesburg:—Photographs, plans and views illustrating the means by which maps and plans were provided by Surveyors attached to the Royal Engineers, to the Armies in the field. (Exhibit lent by Captain H. K. Matthews, R.E.)

15. Mrs. W. W. Lawrie, Loch Avenue, Parktown West, Johannesburg:—A rare Photograph showing a panoramic view of Johannesburg in 1887.

16. Rand Mutual Assurance Co., Ltd., Prevention of Accidents (Safety First) Committee, Cullinan Buildings:—Collection of Safety First Exhibits; Accident "Savers"; Safety First Literature; Inter-Mine Sporting Trophies, etc., etc.

MINERAL PRODUCTS.

1. Budd's Magnesite Mine, Kaapmuiden:—Sample of Magnesite Ore.

2. Consort Mine, Consort, P.O., Transvaal:—Products of Mine: Arsenic, Arsenite of Soda, etc.

3. Doornhoek Lead Mines, Zeerust, or P.O. Box 2893, Johannesburg:—Samples of Lead Ores and Blocks of Galena.

4. Mr. H. Y. Morgan, 46, Plein Street, Johannesburg:—Sample of Silver-Lead Ore from Broken Hill Mine, New South Wales.

5. Scotia Talc Mines, Ltd., Chorlton Chambers, Harrison St., Johannesburg:—Talc, Nickel, and Pigments; Bath, Face and Baby Powders; Electrical Insulators, Oil and Water Paints, and Tiles.

6. Mr. H. A. White, P.O. Dersley:—(*a*) Sample of Copper Ore from Katanga. (*b*) Piece of Native Smelted Copper.

7. Zaaiplaats Tin Mining Co., Ltd., P.O. Sterkwater, *via* Pietpotgietersrust:—Tin Ore, Concentrate, Crude Metal, Slag, Dross, Hardhead, and Refined Metal in the form of ingots, strip and granulated tin.

SAFETY FIRST COMPETITION EXHIBITS.

1. Consolidated Main Reef Mines and Estate, Ltd.:—Model of Skip with Tipping Gear for Compound Shaft, showing locking device (painted red) which prevents disengagement of dogs except in tip.

2. Mr. W. Daly, Village Deep, Ltd., Johannesburg:—(*a*) Driver for Tappet Keys, by the use of which danger to workmen is eliminated. (*b*) Model of Cage with Safety Catch Device. With the breaking of rope on a downward trip, the cage is brought to rest without shock. (*c*) Method of fixing timber on shoe-blocks in Stamp Mills, by which the danger of stamps falling on workmen's hands is eliminated.

3. Mr. O. E. Dirks, Geldenhuis Deep, Ltd., Cleveland:—Safety Bar for Mill Stamps.

4. Mr. T. C. Jarvis, Modder "B" G.M. Co., Ltd., Benoni:—A Safety First "Lock" for H.T. switch house door.

5. Mr. G. Martindale, Modder "B" G.M. Co., Benoni:—Mine Shaft Safety Signalling Device.

6. Mr. J. McCrindle, Knights Deep, Ltd., Germiston:—Safety Finger Wedge for Stamp Mills.

7. Robinson G.M. Co., Ltd., Johannesburg:—Mill Finger Safety Keeper.

8. Mr. E. A. Jackson, Robinson G.M. Co., Ltd.: Incline Safety Gate for use at the head of winze.

9. Messrs. S. D. Saunders and G. H. Sainsbury, Modder Deep Levels, Ltd., Benoni:—Safety Device for Runaway Cage or Skip for Aerial Gears or Vertical Shafts.

10. Mr. W. Thomas, Wolhuter G.M., Ltd., Johannesburg:—Interlocking Gear for Winding Engine.

11. Village Main Reef G.M. Co., Ltd., Johannesburg:—(*a*) Safety Finger Device for Stamp Batteries. (*b*) Mill Plate Steaming Box and Mercury Fume Extractor.

12. Messrs. J. F. Walker and F. C. Bower, Consolidated Main Reef Mine, Maraisburg:—Apparatus for Exhausting Mercury Fumes and Steam from Plate Houses.

13. Mr. H. Ward, Roodepoort United Main Reef G.M. Co., Roodepoort:—Safety and Adjustable Collar for Shafting.

COMMERCIAL EXHIBITS.

1. Messrs. M. J. Adam & Co., Exploration Buildings, P.O. Box 318, Telephone 5984, Johannesburg:—Model Ambulance Station with equipment, with exhibition of enamelled "Safety First" and other plates.

2. Messrs. Bartle & Co., Ltd., Loveday House, Loveday Street, P.O. Box 2466, Johannesburg:—Cleveland Hammer Drill with "Whack-all" Water Blast attachment; Patent Cam Shaft; Green's Pulley Centre.

3. British South African Explosives Co., Ltd., Dynamite Factory, Modderfontein. Town Office: Hosken's Buildings, Fox and Rissik Streets, Johannesburg:—An Exhibit of Explosives and Detonators (dummies); Acids; Samples of Lead Work, Pipes, etc., made at the Factory.

4. Messrs. Broad Roberts Mica Industry, Galpin's Buildings, Commissioner Street, P.O. Box 1777, Johannesburg:—Micanite Sheets, Tubes, Washers, etc.; Clear Mica; Mica Lamp Chimneys; Electric Light Shades; Corundum.

5. Messrs. E. G. Dowse & Co., 199, Anderson Street, Johannesburg:—Jack Hammer Rigs; Shaft Rollers and Hose Connections.

6. French Engineering Works, Ltd., 18, Anderson Street, P.O. Box 4362, Telephone 1609, Johannesburg:—Rock and Diamond Drill Spares and Fittings.

7. Messrs. H. Alers Hankey, 52, Standard Bank Chambers, P.O. Box 3807, Telephone 5892 Johannesburg:—Wright's Wire Ropes; Rockwood Steel Pressed Union Couplings; Chapman's Fullway Gate Valves; Delta Metal; Thurlow's Amalgam Scraper.

8. Messrs. H. S. Potter, Ltd., 26, Cullinan Buildings, P.O. Box 5510, Telephone 4337, Johannesburg:—Typhoon Turbine Blower; Flexoid for Mine Ventilation; Safety First Devices, etc.

9. Swift Patent Water Attachment, 12, London House, P.O. Box 6166, Johannesburg. (MacDonald Adams & Co., Ltd., agents.):—2¾in. Swift Rock Drill with Patent Water arrangement attached; 2¾in. Holman Drill converted from Dry to Water Feed.

10. Ussher Inventions, Ltd., 7, Winchester House, P.O. Box 345, Telephone 1608, Johannesburg:—Ussher Hose and Pipe Clamps; Manifolds; Water Blasts; Jets and Sprays; Saddle Clamps; Jack Hammer Rigs; Hume Pipe Exhibit of Mine Chutes, Ventilating Pipes, Tanks, etc.

"SAFETY FIRST" AWARDS.

The Prevention of Accidents ("Safety First") Committee offered a first prize of a silver medal and a second prize of a bronze medal for the two best exhibit of a safety device, appliance or method of procedure. Seventeen entries were re ceived, and sixteen exhibits actually received. An adjudicating committee consisting of representatives elected by the Society and the Rand Mutual Assurance Co., under the chairmanship of Sir Robert Kotze, the Government Mining Engineer, after having gone fully into the merits of each device, made the following awards :

First Prize of Silver Medal to Messrs. W. Hartz, S. H. Steels, and W. Vorster, of the Village Main Reef G.M. Co., Ltd., for a "Safety finger device for stamp batteries," and the Second Prize of a Bronze Medal to Mr. W. Thomas, of the Wolhuter Gold Mines, Ltd., for an "Interlocking gear for winding engines."

The Committee also Highly Commended the following :—

Mr. W. Fyfe, Robinson G.M. Co., Ltd. :—"A finger locking device for stamp batteries."

Mr. E. A. Jackson, Robinson G.M. Co., Ltd. :—"An Incline Safety Gate for use at the head of a winze."

The following summaries of these devices have been supplied :—

Messrs Hartz, Steels and Vorster : The battery finger safety bar for suspending the stamp when not working consists of a hinged bar attached to the finger, preventing it from slipping out of place when shoes or dies are being replaced. A locking device is an essential part of the attachment, preventing any movement of the fingers away from the stamp. The local price of the attachment complete and fitted to any finger is approximately 30s.

Mr. W. Thomas : The object of the interlocking gear is to prevent the brake of a winding engine being released when the clutch is out, or to prevent the clutch being taken out when the brake is off. The device consists of a plate supported by two brackets and costs less than £1 to instal.

Mr. W. Fyfe : This device consists of an iron clutch fitting round the stem and the finger, which with any vibration tightens itself and cannot fail It costs about 10s. to make, and a supply of 20 is sufficient for a 250 stamp mill.

Mr. E. A. Jackson : The approximate cost of this gate which is for use in winzes when the hauling of rock is proceeding is about £6. (Made up of timber 30s., iron 20s., labour in making 45s., and labour in erection 25s.) The trucks open the gate which closes immediately the trucks have passed through.

LECTURES AT THE EXHIBITION.

During the course of the Exhibition three lectures were arranged by the Preventions of Accidents Committee of the Rand Mutual Assurance Co., Ltd. These lectures were given in the Lecture Theatre of the School of Mines. On Saturday, the 24th January, Mr. J. D. Marquard, Deputy Inspector of Mines, Johannesburg, lectured on "Accidents due to Falls of Rock," Mr. Frank Raleigh presiding. On Wednesday, the 28th January, Mr. John Munro presided, when Dr. A. J. Orenstein, C.M.G., lectured on "Safety First and Health," illustrating his remarks by a number of interesting lantern slides. At this lecture the medals awarded for the two best safety devices were presented by Mr. Munro. Mr. J. D. Marquard again lectured on Saturday, the 31st January, his subject being "Accidents due to Falls of Rock," Mr. J. Forrester Brown occupying the chair. The two mining lectures were followed by a cinema film, illustrating types of actual accidents specially taken underground on the Nourse Mines by the African Films Trust. All the lectures were extremely well attended and were followed by discussion on the points raised by the lecturers.

Notices and Abstracts of Articles and Papers.

CHEMISTRY.

New Researches on Cement.—"A survey of the literature on cement published during the last 10 years. The raw materials for Portland cement do not require special investigation beyond that necessary to secure the correct ratio of $CaO : SiO_2 + Al_2O_3 + Fe_2O_3$ in the finished product. Only glassy blast-furnace slags, which have been cooled rapidly and granulated, can be used for slag cement. If cooled slowly they fall to a useless crystalline powder. The constitution of Portland cement-clinker is not definitely established. Cobb has shown that calcium carbonate, silica, and alumina can react at 800°—1200° C. without fusion, forming calcium silicates at temperatures much below the eutectic temperature. Sodium, magnesium, zinc, and barium silicates and aluminates may also be prepared in a similar manner. The incompletely burned and unsintered product in the manufacture of Portland cement, though largely soluble in *N*/1 hydrochloric acid, contains silicates and aluminates which are absorbed on heating to a higher temperature by the ternary or quaternary eutectic formed. Jesser and Dittler (Zement-Chemie, 1910, 71) observed first an absorption of heat (*i.e.* the fusion of a eutectic) when cement-mix was sintered at 1250° C.—1380° C., and the crystallisation of the chief constituent did not occur until the material had been heated to a higher temperature; this crystallisation was accompanied by evolution of heat. The triangular diagram summarising the researches at the Geophysical Institute, Washington (J.S.C.I., 1911, 543; 1915, 139), is reproduced, but it is suggested that, as equilibrium is seldom reached in burning cement-clinker, the phases indicated in the triangular diagram may not occur in commercial cement. The influence of iron oxide, magnesia, alkalis, and sulphur trioxide on the position of the various areas in the diagram has not been investigated, though it is known that small percentages of ferrous oxide and manganous oxide prevent "dusting." Kellig (Protokoll der Verh. des Vereins deutsch. Portlandzementfabrik., 1913) produced sufficiently large amounts of pure calcium aluminates to permit the examination of their mechanical properties. He confirmed the known high crushing strength of aluminous cement, but found that tricalcium aluminate expands after being mixed with water, and suggested that this substance does not occur in good Portland cement. The setting and hardening of cements have been studied microscopically by Ambronn and others (J.S.C.I., 1909, 366), Kaisermann (Diss., Jena, 1910), Blumenthal (J.S.C.I., 1914, 964), and Scheidler (Diss., Jena, 1915). A 0·2% solution of alizarin orange or cryst. alizarin in dilute ammonia was used to identify lime, a similar solution of cyanin and chromotrop 2R was used to identify alumina, acetic acid for combined silica, and neutral methylene blue for free silica. After the cement and water had been in contact for 2—3 hours, hexagonal plates of calcium aluminate were visible around the cement grains; these plates were free from silica. Fine needles of calcium silicate were also formed. After 3—4 days, large hexagonal crystals of calcium hydroxide appeared; in contact with the atmosphere these formed spherolites of calcium carbonate. Simultaneously, a gelatinous calcium silicate was formed. It was found that these substances are not simply the hydrated products of compounds present in the clinker, but are new compounds formed by the decomposition of the clinker by the water. The hardening of cement appears to be due to the formation and crystallisation of calcium aluminate and silicate and to a gelatinous calcium silicate which unites the crystals present. The increase in volume during hardening has been shown by Jesser (Protokoll der Verh. des Vereins deutsch. Portlandzementfabriken, Berlin, 1913) to be due to the tension of aqueous vapour in the atmosphere. In regard to the destruction of cement by water, etc., sulphates are harmful, but chlorides are negligible. The absorption of the SO radicle from sulphates causes large expansion of the cement and leads to its destruction. Synthetic calcium aluminium sulphate is decomposed by sodium chloride, magnesium chloride, and sea water, and its formation in sea water is therefore improbable. The expansion of cement in sulphate solutions increases with its content of alumina. Prolonged exposure to the air previous to immersion in the sulphate solution reduces the expansion, possibly on account of the decomposition of the calcium silicate and hydroxide by the carbon dioxide in the atmosphere. When cement is immersed in a magnesia solution, an equivalent amount of lime is replaced by magnesia."—K. Endell. *Z. angew. Chem.*, 1918, *31*, 233.—*Journ. Soc. Chem. Ind.*, Feb. 15, 1919, p. 76a. (J. A. W.)

Oxidation and Ignition of Coal.—"In a series of experiments in which air or oxygen was circulated in a closed system through a column of powdered, freshly won coal heated in a constant-temperature oven, the rate of disappearance of oxygen being measured by the fall in pressure, results have been obtained which, in general, agree with those recorded by previous investigators. The occluded gases which can be removed from a sample of coal by exhaustion at 100° C. contain a large proportion of the oxides of carbon if the coal has been previously "weathered" either naturally or artifically, and in this respect differ from the gases which are removed from newly won coal. Comparative experiments, in which the gases were removed at 15° C. and at 100° C., show that although some oxygen is occluded by coal and can be removed at the ordinary temperature by physical means, the major portion of the oxygen retained by the weathered coal only makes its appearance in the form of oxides of carbon when the temperature of the coal is raised. The results suggest that the first step in the oxidation of coal is the formation of an addition compound or complex of oxygen with one or more of the substances present in the coal. Incidentally it has been found that the quantity of gas removed from a weathered coal by exhaustion at 100° C. is considerably increased when the coal has been "weathered" by contact with air dried over calcium chloride. In order to determine what relationship, if any, there is between the chemical composition of a coal and its ignition temperature, a number of coals were tested by heating finely powdered and sifted samples in tubes embedded in a sand bath the temperature of which could be slowly raised by electrical heating, a current of air being drawn through the column of coal at constant speed. Thermometers embedded in the coal and in the sand respectively were read at frequent intervals. Two temperature-time curves were thus obtained and it was found that these curves intersected at a certain temperature. This temperature is regarded for comparative purposes as the "ignition temperature." The results obtained with samples of coals containing different quantities of oxygen show clearly that the most highly oxygenated coals are those which have the lowest "ignition temperature" and are therefore most liable to self-heating. It is probable that such highly oxygenated coals contain considerable quantities of substances, the molecular structure of which approximates closely to that of carbon. The reaction responsible for the self-heating is supposed to consist in the attachment of oxygen to molecules of this type."—R. V. Wheeler.—*Chem. Soc. Trans.*, 1918, *113*, 945.—*Journ. Soc. Chem. Ind.*, Feb. 15, 1919, p. 65a. (J. A. W.)

Preparation of Soluble Starch.—"A mixture of wheat, rice, or maize starch, 25, alcohol (95%), 100, and sulphuric acid, 5 gm., is boiled for 15 mins. under a reflux condenser; the starch is then collected on a filter and washed with water until free from acid. If it is desired to dry the starch rapidly, it may be washed with alcohol in place of water. The product is readily soluble in hot water and the solution gives a clear blue coloration with iodine."—A. Leulier.—*J. Pharm. Chim.*, 1918, *18*, 291. *Journ. Soc. Chem. Ind.*, Feb. 15, p. 86a. (A. W.)

METALLURGY.

World Production of Chromium Ore.—"The following table gives the output of chromium ore, containing an average of about 50 per cent. of chromic oxide, in the principal producing countries:—

Metric tons	New Caledonia	Rhodesia	Canada	U.S.A.
1906	57,307	3,308	7,936	10
1907	31,552	7,273	6,528	24
1908	46,890	12,118	6,554	364
1909	40,000	37,024	2,470	605
1910	40,000	40,002	279	208
1911	82,806	47,000	143	122
1912	51,516	62,850	—	201
1913	63,370	63,384	—	251
1914	48,852	49,009	123	601
1915	67,000	61,590	11,196	3,326
1916	74,116	88,871	24,522	48,943
1917	?	?	36,352	41,000

Anon. *Wirtschaftdienst*, Jan. 10, 1919.—*Journ. Soc. Chem. Ind.*, Feb. 28, 1919, p. 68r. (J. A. W.)

Electrolytic Gold and Silver Refining at Perth Amboy, N.J.—"An illustrated description is given of the treatment of doré bullion, by the Moebius process, at the works of the American Smelting and Refining Co. The bullion forms the anode of an electrolytic cell having a cathode of pure silver, the electrolyte being a neutral solution containing 15—20 gm. of silver and 30—40 gm. of copper per litre (as nitrates); a current density of 40 amp. per sq. ft. is employed. The insoluble residue (gold slime) from the anodes—collected in bags by which the latter are enclosed—is treated with sulphuric acid to remove silver and copper and is then melted and cast into anodes for electrolytic refining by the Wohlwill process For this purpose, cathodes of thin sheet gold are employed in an electrolyte containing 30% of free hydrochloric acid and 80—85 gm. of gold per litre, the current density being 150 amp. per sq. ft."—G. G. GRISWOLD. *Am. Electrochem. Soc., April, 1919. Journ. Soc. Chem. Ind.*, March 31, 1919, p. 181A. (J. A. W.)

MINING.

PRELIMINARY STEPS IN THE DEVELOPMENT OF A GRAPHITE DEPOSIT.—"Probably no other branch of mining offers a wider field of general investigation than that of graphite and the many failures in this industry may be attributed in the majority of cases to venturing without accurate preliminary knowledge of its various sub-divisions such as the nature of the deposit, the mining, the refining, the uses, the marketing, etc.

The value of a graphite deposit depends firstly upon the physical and chemical properties of the contained graphite; secondly, upon the tonnage and tenor of the ore available for milling purposes; and thirdly, upon the process of refining and the market.

Graphite differs from most minerals in that an average assay sample from a deposit may have a relatively low value when measured by the physical properties as standardized by the consumer. The bulk of graphite marketed goes into the manufacture of crucibles and this grade commands the highest price, and the consumer specifies that the stock shall have a moderately thick flake, shall pass through a standard 16 mesh screen, at least 50% shall pass over a standard 50 mesh screen and the whole shall pass over a standard 90 mesh screen and in addition shall contain at least 85% to 90% or more graphitic carbon and shall be free from such impurities as lime, iron, mica, sulphur, etc. The foregoing specifications eliminate all the finely flaked or so-called "amorphous" graphite from this particular demand and classifies it with the lower grades of graphite with which the market is usually stocked and for which consequently prices are very low. It is, therefore, important that the deposit shall contain distinctly flaky graphite and that the flakes are not too thin and of such dimensions that all or practically all shall be larger than that set forth in the specifications of the consumer of the higher grades. The higher the graphitic carbon content of such a deposit, the more valuable the deposit.

The quality of the graphite of a deposit should be considered from the chemical as well as from the physical standpoint, for if the flake be intimately interlaminated with very thin plates or scales of a micaceous decomposition product or other impurities, the grade of the refined graphite may be low if subjected to ordinary ore-dressing just sufficient to liberate the composite flake from the surrounding gangue, and any attempt at further refining may have the desired effect chemically, *viz.*, to raise the graphitic carbon content, but at the expense of lowering the grade physically by creating a thin flake. This thin-flaked refined stock causes a further increase in volume per unit mass of the refined flake and thus renders it less suitable for the purpose of crucible manufacture, and in addition the extra refining usually creates an abnormal quantity of fines or low-grade stock. There are exceptional cases where this enclosed foreign matter has been noted to run as high as 10%. It would be almost impossible to successfully treat ore from such a deposit in order to produce gold crucible stock as it would mean the elimination of all the remaining impurities. The writer has had several analysis of flake from well-known Canadian deposits and has not as yet found flake wherein the involved impurities exceeded 1·10%, although a great many flakes contain coarse interlaminated marginal impurities such as pyrite, quartz, calcite, etc. Those impurities penetrate laterally into the jagged margin of the flake by a relatively short distance, and are practically all removed by proper ore-dressing methods without serious injury to the flake.

A study of the nature of the occurrence of the graphite of a deposit is also an important factor in the determination of the value of a deposit. As a rule the best flake occurs in the softer gangues such as crystalline limestone, schists, etc., or in fissure veins containing little else than graphite and formed apparently under pneumatolitic conditions such as the Ceylon deposits. Much of the flake in the hard gangues such as quartz, etc., is thin and more apt to disintegrate in the process of refinement, while the flake in the softer gangues may be liberated with the minimum injury to the flake. Some of the best Canadian deposits occur in the above-mentioned soft gangues and are designated as "disseminated" flake graphite deposits and usually contain from 5% to 20% graphitic carbon. In excess of 20% the flake appears to become crowded and smaller and loses the characteristic uniformity of size and the ratio of crucible stock to the whole graphitic carbon content falls off very rapidly. A fair average graphitic carbon content for an ideal deposit such as the above would be between 10—12%.

Another feature which contributes to the value of a graphitic deposit is the percentage of good crucible stock that may be recovered from the ore. A mill may be designed to effect a complete extraction of the graphite content of the ore, yet in the dressing of the ore for such extraction the flake is so impaired that a relatively small proportion of the whole is recovered as the best grade. The measure of efficiency of a graphite mill is therefore not the extraction altogether, but for comparative purposes may be designated as follows:

$$\frac{\text{Weight of graphite recovered as No. 1 crucible stock from ore treated.}}{\text{Total weight of graphitic contained in the ore treated}}$$

calculated as a percentage, and the value of a deposit varies as the efficiency of the mill. It is therefore very important before constructing a mill to select the most efficient process for the particular or by submitting representative samples for mill test to the various types of concentrating machines.

A certain process may recover a fair percentage of stock that will pass over a standard 90 mesh screen and analyze 90%, plus graphitic carbon and apparently resemble good crucible stock, but due to over refining in order to raise the graphitic carbon content the stock will not classify as good crucible stock on account of failing to meet the mass volume test."—C. Spearman.—*The Canadian Mining Journal*, 6th August, 1919, pp. 586 and 587. (C. J. G.)

MISCELLANEOUS.

The Training of Students in Coal Mining, with Special Reference to the Scheme of the Engineering Training Organisation.—"The Engineering Training Organisation has been formed to serve as a central organisation for improvement in and better co-ordination of engineering training. Those objects in particular are mentioned on which the proposed central organisation might usefully concentrate its attention, namely:—(1) The co-ordination of engineering training, including the fostering of apprenticeship as a national institution, and the consideration of means by which the works period of an engineering pupilage may be increased in efficiency, and a wider appreciation secured for the value in industry of university rank. (2) The maintenance of a Central Bureau, where parents and educationists can obtain accurate and comprehensive information relating to the engineering industry, and the proper course to pursue on behalf of boys who are desirous of making engineering their profession. (3) The promotion of scholarships, or other equivalent means by which the best talent may be enabled to rise to its proper level under the stimulus of educational opportunity.

Taking the second of these objects first, the work of such a Central Bureau must depend on the information given to it by the various branches of the engineering profession. Hitherto the Institution of Mining Engineers has issued no instruction on this subject, although several very interesting papers have been contributed to the "Transactions," whilst the discussions on these papers have revealed a variety of opinions, and have shown that a large amount of interest is taken in the matter. All members are acquainted with the various ways in which entry into the profession of mining may be obtained, and in case of doubt on any point they know where to apply for information. It must, however, be remembered that this knowledge is not available to persons outside the mining profession, and can only be obtained by them with some difficulty. The choice of a profession for their sons is not an easy task for some parents, who do not know where to apply for the information necessary to enable them to decide on this important point. It may possibly be due to this difficulty of obtaining information that in some cases the choice of a boy's career is postponed until he is about to leave school; it is then too late to rectify any omissions in the latter part of his school training, and either the boy must be put to work partially equipped, or time must be spent on a subject, or subjects, in which he might have had instruction at school. If professions and industries give some clear and definite indication as to what is required, then the schools can make their arrangements in accordance with them. In this way there would be a better co-ordination of work.

The arrangements of a scheme of education in coal mining differs from similar work in most other branches of engineering in that such a scheme must conform to the requirements of the Coal Mines Act, 1911, respecting the First-Class Certificate of Competency and the Surveyors' Certificate, and to the rules laid down under that Act by the Board for Mining Examinations. These are, of course, minimum requirements, but whatever else may be added by professional opinion, care must be taken that the legal requirements are not infringed. Any general statement, therefore, relating to the course to be pursued by a student in coal-mining should explain any technical points which would not be understood by a person not connected with the mining profession, and those who are personally interested should be referred to the Home Office on matters of detail or doubt, and as to changes in the regulations.

The training of students who propose to take the First-Class Certificate of Competency may be conducted on one of three lines, namely:— (1) Attendance at an "approved" institution, obtaining an "approved" degree or diploma, and serving as an articled pupil at a colliery for a period of not less than three years. (2) Service as an articled pupil at a colliery for not less than five years. (3) Practical experience (as defined in the rules of the Board for Mining Examinations) for not less than five years at a colliery. Although these various kinds of training present marked differences, yet to some extent one class overlaps the other. In all of them attendance at courses of technical instruction is possible; in the first it forms a necessary part of the training.

Divergent as are the views which have been expressed on the subject of the best training for coal mining students, it will probably be found that there are courses already in existence to suit every variety of opinion. There are about fifteen institutions on the "approved" list, and some of these have both degree and diploma courses. A detailed account of each course does not seem to be necessary; information is required chiefly under the following heads:—(1) Regulations as to entrance; in the case of degree students by matriculation, or by passing an examination which is recognised by the particular institution as equivalent to matriculation; in the case of diploma students whether there is any entrance examination, and, if so, in what subjects. (2) Length of course. (3) General outline of course. (4) Academic distinction awarded. (5) Whether there are any vacation courses which students are expected to attend. (6) Whether the regulations provide for practical work during the vacations. (7) Whether students are trained in coal mining only, or whether instruction is given in other branches of mining. As the regulations concerning these courses may be changed in the future, it should be explained that the information given refers only to existing conditions.

A recommendation has been made, especially in recent years, that after leaving school, and before entering a university or college, a boy should spend some time in practical work. A year is generally mentioned, but nine months has also been suggested. The object of this is to give the boy an insight into his professional work, and to bring him into touch with it at an earlier age than would otherwise be the case. This proposition requires very careful consideration, and it would be interesting to know whether the result has been satisfactory in any cases in which it has been put into practice. It may be questioned whether the beneficial effect of the practical experience so acquired is not set off by a loss of knowledge already acquired, which would have to be learned again when the student enters on his applied science training. This, however, is a point which can only be decided by experience.

On this question it would be interesting to know to what extent intermittent periods of practical work at a colliery are allowed to count towards the minimum period of three years required by the Coal Mines Act for this class of student.

The training of the articled pupil has next to be considered—that is, the student who enters into articles for five years, as distinct from those students who take a degree or diploma and become articled subsequently.

Some of the "approved" courses are probably so arranged that they can be taken by pupils while serving their articles. A course of this kind, mentioned by Mr. G. Blake Walker in the discussion on Mr. R. W. Dron's Paper on "The Training of Mining Engineers," appears to be arranged on the "sandwich" system—that is, six months at the university and six months at the colliery—a system which has already been in practice for some years for students in mechanical engineering. Where no arrangements are made for articled pupils to attend a course of this kind, they can gain some knowledge of the necessary science and applied science subjects by attendance in their spare time at such classes as may be within their reach established by the university or college, or by the local education authority Probably in every district there exist facilities of this kind, in most cases organised courses held either in the evening or on Saturday afternoons, and these are available also for those who obtain the Certificate of Competency in the third way indicated previously—that is, by practical work in the mine.

Among the points mentioned in the first of the objects of the Engineering Training Organisation is "The Fostering of Apprenticeship as a National Institution." This is explained more fully in "The Engineering Pupilage and the Engineering Trade Apprenticeship," by Mr. Algernon Berriman, O.B.E., to which reference should be made. As the terms "articled pupil" and "apprentice" are in some cases used as though they were identical, it may be as well to state that in Mr. Berriman's Paper the difference is defined thus—the "articled pupil" goes into the works in order to gain knowledge of the way in which the work in various departments is carried on, and to obtain an insight into the details of the organisation: he does not do so in order to acquire manual skill. The object of the "apprentice," on the other hand, is to acquire such knowledge as will make him a skilled workman, and the scheme outlined in Mr. Berriman's Paper is drawn up with the idea of enabling the apprentice to do this, while at the same time careful attention would be paid to his technical education at a school or college, and opportunities would be given him of gaining experience in various departments of the works. This, however, is not the whole of the scheme, since those apprentices who showed the greatest promise would be given the opportunity of carrying their training still further. In this way young men of talent would receive an excellent technical education, while those who were less gifted would obtain a sound training that would enable them to do useful work in their profession.

It is a matter for consideration how far these suggestions can be applied to coal mining, and for inquiry as to whether anything has been done in this direction. Schemes which appear to be somewhat similar have already been mentioned in the "Transactions" by Mr. G. Blake Walker and by Prof. W. Ripper, as being either in contemplation or in operation in the neighbourhood of Sheffield; and similar schemes in other parts of the country were alluded to by Dr. Henry Briggs and by Prof. George Knox in the discussion on Mr. G. L. Kerr's Paper on "The Higher Training of Colliery Managers." Details of such schemes, and information as to the experience which has been gained in working them, would be of great interest, and would be useful to those who contemplate the idea of attempting something similar.

The other points which are dealt with in the programme of the Engineering Training Organisation may be left for future consideration when they have been more fully developed.—*Iron and Coal Trades Review*, December 1918, p. 638. (J. A. W.)

Abstracts of Patent Applications.

494.18. General Electric Co. Improvements in and relating to the manufacture of steel. 15.8.18.

This application relates to improvements in the manufacture of steel, and while of general application to steel manufacture, it applies more particularly to the manufacture of so-called alloy steel in which there is incorporated with the steel one or more rare metals.

252.19. J. Keith (1), G. Keith (2), & W. A. Whatmough (3). Improvements in and means for controlling the supply of combustible mixture for internal combustion engines.

This application refers to an apparatus for controlling the supply of a mixture of fuel and air to an internal combustion engine fed by an induction pipe fitted with a throttle valve and having a tubular connection with a source of fuel supply, delivery from which is regulated by an obturating member, characterised by the arrangement of a governor device influenced by pressure functions of the components of the mixture and adapted to maintain a difference of pressure across the obturating member proportionate to the difference between the pressure at the point of entry of fuel into the induction pipe and the pressure at some other selected point.

The principle of the apparatus described in the application is that of vaporising fuel such at petrol or paraffin, and regulating the amount of vapour which is to mix with the air in the induction pipe of the combustion engine instead of injecting such liquid fuel by means of a jet directly into the induction pipe as is done in the ordinary carburettor.

342.19. E. H. Emerson. Improvements in or relating to the concentration of ores and apparatus therefor. 5.5.19.

The application relates to an improvement in flotation concentration, and consists of a pulp feed box connected by a pipe to the top of a barrel-shaped vessel, being one of a series wherein the ore pulp is subjected to æration and agitation. This latter is accomplished by means of a hydro air injector which imparts a high velocity to the incoming pulp stream. The mineral-carrying froth overflows the top of the barrels and the tailing flows upward from the bottom of the first barrel through a connecting pipe into the top of the next lower one in the series.

487.19. E. S. Leaver. Apparatus for extracting metals from their ores. 24.6.19.

This application is for an apparatus patent in connection with the sulphurous acid method of extraction of copper, in which the pulverised ore is fed into a rotary drum provided at one end with a pulp inlet and gas outlet, and at the opposite end with a pulp outlet and gas inlet, whereby ore pulp and gas may be passed in counter-current through the drum. The drum is provided with a series of perforated partitions extending acoss it, and a series of bucket lifts at the periphery whereby the ore pulp is continually lifted and dropped through the gas passing through the drum.

526.19. G. B. Gordon. Improvements in the construction of shaft lime kilns. 3.7.19.

This application is for certain constructional details of shaft kilns, the main features of which are: The use of reinforced concrete in the shell, lower deck, supporting piers, etc., and girders between the piers with grate bars spanning the girders which support the charge in the shaft. A screening table is removably arranged below the grate bars, with a section on which the product can be broken.

527.19. G. B. Gordon. Improvements in concrete lime kilns. 3.7.19.

Similar to Application No. 526.19, but arranged for forced draught, with tuyeres arranged round wall of shaft and arranged to force air into upper part of charge or, alternatively, to draw air downward from top of shaft, and removal of carbon dioxide.

563.19. Fullerton, Hodgart & Barclay, Limited, (1); W. McGregor (2). Improvements in and relating to air compressors. 21.7.19.

This application refers to improvements in air compressors, the valves being of the grid-iron type, arranged to have all the slots and bars of the same length and disposed in a rectangle, the valve being guided at its end in notches or recesses formed in the end bars.

662.19. H. S. Hele-Shaw. Improvements in hydraulic clutches or couplers. 18.8.19.

This application refers to a hydraulic clutch comprising one member having pistons operating in cylinders which are open to a closed circuit or channel, so that any movement of one piston is accompanied by corresponding movement of another or others; a valve for controlling at will the facility for circulation of the liquid in the closed circuit or channel; means for automatically introducing liquid into the circuit for maintaining said closed circuit or channel full under all working conditions, and a second member comprising essentially a mechanism corresponding to a crank giving to the pistons the movement they would have if actuated through a connecting rod of infinite length, for co-operating with the pistons.

671.19. Fullerton, Hodgart & Barclay, Ltd. (1). W. McGregor (2). Improvements in and relating to the valves of pumps. 19.8.19.

This application is for an improved type of valve for water pumps dealing with heavy pressures, say, 500 lb. per sq. in. and upwards.

The openings in the valve seat are made oblong in shape, and the moving portions of the valves are thin, rigid plates of tough steel rectangular in form, covering the said openings and arranged to lift vertically from the face of the seat. These valves are guided at their ends in a frame or case secured to the valve seat by studs, and provided with a strong spiral spring operating in a suitable recess formed in the frame and bearing on the back of the valve plate to ensure its closing.

The object of the application is to reduce the weight of the moving portion of the valve without the use of flexible steel plates, which, it is stated, give trouble by failure and breakages.

A special claim is made for rounding the edges of the openings in the valve seat and the lower edges of the valve plates, which is said to reduce eddying in the water delivery and to avoid, or minimise, interference between the deliveries from the openings. The openings in the valve seat are also enlarged on the under-side to permit an easy flow of water to the actual valve opening. This arrangement of valve is practically identical with the one described in No. 563.19 by the same applicants for use in air compressors.

727.19. Philip Poore. Improvements relating to the distillation of wood, woody fibre, and similar carbonaceous substances. 10.9.19.

This specification describes the destructive distillation of wood, woody fibre and similar carbonaceous substances in stationary retorts, or retorts rotated continuously or periodically, and has for its object the introduction of steam into the retort at a temperature of 180° C. to 270° C. throughout the active period of distillation to increase the yield of acetic acid, wood naptha, and other distillation products.

802.19 G. A. Hedberg. Improvements in the manufacture of explosives. 30.9.19.

The application claims the use in explosives of ground pine bark, alone or mixed with ground pine cones.

Changes of Address.

W. H. GRAHAM, *l/o* Bushtick Mine, Rhodesia: Panda, Likasi Mine, Congo Belge.

J. C. MANCE, *from active service*; Sandye Place, Sandy, Beds, England.

THE JOURNAL
OF THE
Chemical, Metallurgical and Mining Society
OF SOUTH AFRICA.

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Proceedings
AT
Ordinary General Meeting, February 21, 1920.

The Ordinary General Meeting of the Society was held in the South African School of Mines and Technology Building, Johannesburg, on Saturday, 21st February, 1920, Mr. Jas. Gray (President) in the chair. There were also present:—

17 Members: Messrs. G. A. Watermeyer, C. J. Gray, J. J. R. Smythe, E. M. Weston (Members of Council); J. Brown, P. Friedman, L. D. Hingle, J. Kennedy, F. Mills, J. D. O'Hara, J. Thorlund, W. E. Thorpe, J. W. Travers, John Watson, H. R. S. Wilkes.

5 Associates: Messrs. J. A. Boyd, O. A. Gerber, J. Gibson, H. Rusden, and D. J. Thomas.

7 Visitors, and Fred Rowland (Secretary).

MINUTES.

The Minutes of the Ordinary General Meeting, held on 15th November, 1919, as recorded in the November *Journal*, were confirmed.

GENERAL BUSINESS

Messrs. J. Watson and C. J. Gray having been elected as scrutineers in connection with the election of new members, the following were declared unanimously elected:—

BROWN, HARRY JAMES, 80, Hatton Garden, London, E.C.1. Metallurgist.

MCMASTER, GLEN A., Simmer Deep, Ltd.: P.O. Box 178, Germiston. Mill Shiftsman.

TELFORD, WILLIAM, City and Suburban G.M. Co., Ltd., P.O. Box 1026, Johannesburg. Mill Foreman.

The Secretary notified that the following Associate had been admitted by the Council:—

LEDEBOER, JOHN LOUIS ADRIAAN, Mijnbouw Maatschappij, Poleleh, North Celebes, Dutch East Indies. Mining Engineer.

OBITUARIES.

The President: The losses by death which the Society has suffered since our last meeting have been heavy, and among them we regret to report the death of Dr. Julius Loevy, who was a foundation member of the Society and President in 1898-9.

I have also to report the death of Dr. Donald Macaulay, a past Vice-President of the Society. In collaboration with Dr. Irvine he presented contributions to the Society on the subject of Miners' Phthisis, and his work in this connection will always be remembered. Dr. Macaulay, as it will be recalled, met his death very tragically some three weeks ago.

Mr. C. D. Leslie was killed in the accident to the Natal mail train at Fortuna Siding last week. Mr. Leslie was the initiator of the movement which resulted in the formation of the Government Industries Advisory Board and the Scientific and Technical Committee, which bodies have now been amalgamated and are now known as the Government Advisory Board. He was the immediate Past President of the S.A. Institution of Engineers.

Senator Samuel Marks died a few days ago; he was an outstanding personality, and was responsible for the promotion of many industries in South Africa.

I would ask you, as a mark of respect, in memory of these gentlemen, to rise in your seats. All members rose.

THE MINING EXHIBITION.

As you all know, the Exhibition successfully terminated at the end of last month. We have to thank the Chamber of Mines for guaranteeing to meet the small deficit which resulted.

MEMBERSHIP OF COUNCIL.

I have to report that the Council has elected Major T. G. Trevor to fill the vacancy caused by the retirement, on account of ill-health, of Mr. H. C. Hilton.

THE ANNUAL DINNER.

We hope to hold the Annual Dinner at an early date. The Annual Dinner has fallen into abeyance during the war, but we hope to have a revival within the next month or two, and I am sure it will meet with the cordial support of all members.

RESIGNATION OF SECRETARY.

I regret to have to inform you that Mr. Rowland, who has been our Secretary for the past 23 years, has resigned in order to take up the Secretaryship in connection with the South African Red Cross Society, a body with which he has been connected in the capacity of Honorary Secretary since its formation some five or six years ago.

There is no necessity for me, in an assembly of members of the Chemical, Metallurgical, and Mining Society of South Africa, to dwell on the devoted services which Mr. Rowland has rendered to the Society and its affairs since he first attended a meeting of Council on the 30th November, 1896.

You must be all aware of the great loss the Society suffers by his resignation. Mr. Rowland was more than a Secretary; Mr. Rowland was a personal friend to everyone of us—(applause)—and, I think, in that respect, we will all miss him; but I have no doubt, from force of habit, he will sometimes find himself here on the third Saturday of the month. This will be the last official occasion, I regret to say, on which Mr. Rowland will be present in the capacity of Secretary, and on your behalf I wish him success and prosperity in his new appointment. (Applause.)

Mr. Fred Rowland (*Secretary*): It is extremely difficult for me to adequately acknowledge the kind manner in which the President has referred to my services to the Society. I shall feel the wrench of parting from the work with which I have been connected for so many years, more than I can say, to say nothing of severing my official connection with the very many friends I have made amongst the members, from whom at all times I have received the greatest consideration. I have only taken this step after much consideration, as I felt that the work which I am about to undertake may be, perhaps, of greater service to the community generally, than that which I am regretfully relinquishing. In conclusion, I can only say how gratefully I appreciate the manner in which you have responded to the many kind expressions of the President. Thank you, very much.

WELCOME TO MR. JOHN WATSON.

The President: I am sure I should be neglecting my duty if I did not extend, on behalf of the Society, to Mr. John Watson, a very cordial welcome on his return from India.

GOVERNMENT MINERS' TRAINING SCHOOL.

As you are aware, the Council some time ago decided to invite essays from students at the Government Miners' Training School, on the subject of "Stoping with Hammers and Machines, with suggestions for obtaining greater efficiency underground." These papers, which were received towards the end of the year, have now been adjudicated upon, and the report of the adjudicators is as follows:—

> As the Committee appointed to consider the essays on "Stoping with Hammers and Machines, with suggestions for obtaining greater efficiency underground," submitted by apprentices of the Government Miners' Training School, we have to report:—
>
> (a) That 12 essays were received.
>
> (b) That they were generally excellent and highly creditable to the writers, and to the training received at the School.
>
> (c) That we are of opinion the prizes should be allotted as follows:
>
> First: A. H. Miller.
> Second: H. H. Alexander.
> Third: J. H. Taylor.
>
> and that A. Gilmour should be highly commended.
>
> (Signed) J. CHILTON.
> „ C. J. GRAY.
> „ C. H. GREATHEAD.

The First Prize is a Mineral Cabinet, which has been presented by Mr. Miles Sharp.

The Second Prize has been awarded to Mr. H. H. Alexander and consists of Books and Instruments to the value of three guineas.

The Third Prize has been awarded to Mr. J. H. Taylor and consists of Books and Instruments to the value of two guineas.

The prizes were then presented to the successful competitors.

The Secretary: Mr. Wonnacott, the Superintendent of the School, advised me to-day that he was very sorry that, owing to indisposition, he was unable to be present this evening. He wished me to convey to the Society an expression of the great appreciation felt by his Committee and himself for the assistance which the Society has given the School by affording it an opportunity of competing for the prizes. They are very grateful indeed, and Mr. Wonnacott has found it of considerable service and advantage to the students.

The President: I would ask you to accord a very hearty vote of thanks to the adjudicators for the work they have done in going through the essays and arriving at the awards. The vote of thanks was agreed to unanimously.

CAN AMALGAMATION BE DISPENSED WITH?

By E. M. Weston (Member of Council).

What is Amalgamation? Thomson, in "Stamp Milling and Cyaniding," says, "Amalgamation is the art of making amalgams; but in metallurgical parlance the word is limited to the means adopted for the recovery of gold and silver from ores by the aid of mercury. . . . . Mercury gives definite amalgams with gold and silver and other metals." Two have been recognised, viz., Au_{19} Hg_3 and Au_{19} Hg_4. Read gives the best discussion on amalgams. Thomson continues: "In order that amalgamation or union between gold and silver and mercury can take place they must be brought into intimate contact." Three methods have been used.

(1) Grinding surface. (2) Surface contact. (3) Immersion contact.

Grinding contact is brought about by the use of grinding pans, is expensive and wasteful, and is only now used on a small scale.

Surface Contact.—Copper plate amalgamation was invented in California in 1860. The action of the copper plate covered with mercury is simple, as the film of pulp flows over the plate, the heavier particles of gold naturally seek the bottom of the film, and come in contact with the mercury surface. The mercury at once seizes on the gold particles and causes them to adhere to the plate. It has been pointed out by Read—(Proceedings A.I.M.E., May, 1906)—that "if the particles of gold are of smaller diameter than the thickness of the mercury films there is no disturbing effect. If the diameter of the particle is greater than the thickness of the mercury film the surface tension of the mercury causes it to pull the particles down with considerable force, in addition to its settlement by specific gravity. Amalgamation is more effective when the plate is covered with gold amalgam. Plate amalgamation has the advantage that the surface is easily inspected and the gold amalgam readily removed."

Immersion Contact.—"The idea of passing pulp through mercury is quite out of date."

Lock, in "Gold Mining," writes: "Amalgamation is essentially dependent on two conditions, first that the gold be free (and clean); second, that the particles are of such size and shape as to be able to bring their superior specific gravity into play, and these come in contact with the mercury surface presented to them."

Henry Louis, in "Stamp Milling," writes: "Amalgamation, or the combination of gold with mercury, is a chemical operation which proceeds by surface contact, and therefore demands a certain time for its completion. All that is needed to insure its completeness is that clean gold is brought into contact with clean mercury for a sufficiently long period for thorough combination to take place."

T. T. Read (in a paper read before the American I.M.E., May, 1906), writes: "Amalgamation is a physical process. The gold grains are wetted by the mercury and sink beneath the surface of the mercury film." He states that the reason plates "set" with gold and silver amalgam are more efficient in catching gold is due to the fact that they carry a deeper film of mercury. I do not know if any experiments have ever been made in support of this hypothesis. There seem to be some reasons to question it.

The surface tension of mercury decreases with rise of temperature, and the force tending to draw down particles disturbing the level surface decreases. On the other hand, the decrease of tension makes the wetting of the gold easier; hence the plate catches more gold. Mercury does not wet the gangue or pyrite, hence it is not retained. Black sand consists very largely of "middlings," i.e., pieces of gold not wholly freed from pyrite, hence it is retained.

T. A. Rickard states that there are three amalgams in practice, one containing 0·01 to 0·06% gold, an amalgam corresponding to native amalgam containing 39 to 41·63 Hg, formula $Au_3\ Hg_2$; and the third consisting of coarse gold, having an outer skin of amalgam. Ores containing talc, serpentine, graphite or clay are liable to cause sickening of the mercury. Mercury evaporates slowly at ordinary temperatures, more rapidly at 100° F., and in most dangerous amounts at 212°F.

Hindrances to Amalgamation.—These may be divided into: First, adverse chemical and mechanical conditions of the gold; second, adverse chemical condition of the mercury and amalgam; third, adverse mechanical and physical conditions governing the operation.

Gold is sometimes covered with films of various oxides or sulphates. This has occurred in the oxidised zone of ore bodies on the Rand, and may occur in depth near faults and water courses. It is stated that gold that has been heavily pounded, unless it has been annealed, will not amalgamate. Gold particles in the Rand mills, especially in the older mills, are always liable to have this state induced. The mercury may be affected by acid water. Old members of this Society may remember Mr. J. R. Williams' paper in 1899* on the benefits of amalgamation derived from adding lime to the mortar box; an excess of lime, however, produced brittle amalgam. The mercury may be sickened by the presence of sulphides of the base metals, etc., and when on the plate by copper from the plate dissolved in the mercury, which on exposure forms oxides, causing stains on the surface and bad amalgamation.

Adverse Mechanical Conditions.—If the flow of pulp is too rapid, and if the pulp is too coarse, the plates may be stripped of their amalgam and the finer particles of gold may also be carried off without being freed, or if free coming into contact with the plate long enough to be "wetted," this sometimes takes time. The pulp may be too thick and the plate too flat, causing deposits of sand on the table preventing contact. Especially does this happen when the proportion of other minerals as heavy sulphides or oxides in the ore is high. If too much mercury is added, the amalgam rolls off the table, and if too dry the brittle amalgam is carried away as the finest of slime, the amalgamation is thus always steering between Scylla and Charybdis. Before we consider amalgamation as practised on the best plants of the Rand to-day, it may be instructive if we glance over the history of amalgamation on the Rand, as related by metallurgists.

J. R. Williams wrote in 1899[1]: "I have also noticed that when these vanners are in use that a fair proportion of amalgam is caught on the vanners. With inside amalgamation the loss of mercury is twice that with outside amalgamation"

P. S. Tavener wrote in Aug., 1903[2]: "He had observed floured amalgam passing two 'spitzkasten' and one 'spitzluten' and amalgam escaping in a finely divided state." The amalgam also escaped in large lumps, and amalgam was not easily soluble in cyanide solution. By means of shaking tables A. M. Day, on the Nigel Mine, recovered 300 oz. of such amalgam escaping from the tables per month. Mercury losses were as high as 0·16 oz. per ton, later on reduced to 0·07 oz., or 3 oz. per oz. of gold recovered, and later again reduced to 0·17 oz. Some brainy person observed the remarkable fact that 95% of the amalgam was recovered on the first three feet of the 15 ft. plates.

H. R. S. Wilkes, in 1904,[3] wrote: "The millman who knows how to prevent the departure of amalgam and mercury via launders will have a rosy future."

G. O. Smart, in 1904,[4] finds that the installation of good amalgam traps is essential.

J. E. Teesdale, in 1906,[5] working on ore in Rhodesia containing sulphides of antimony, arsenic, bismuth and copper, found that, despite the fact that his copper plates caught gold all the way down, amalgam accumulated between the riffles of the Wiltley table working below them.

W. A. Caldecott, in 1908,[6] writes: "There is no doubt that the percentage of recovery by amalgamation in the early steps of starting a new mill is by no means satisfactory."

G. O. Smart, in 1909,[7] writes: "If the plates are not scraped down to bare copper a practice only too common on the Rand"

G. H. Fison, in the "London Mining Journal," September, 1909,[8] writes: "Gold amalgam, being a solution of gold in mercury, the increase of temperature of feed water up to, say, 80° F., is conducive to good amalgamation by causing increased

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* This Society's Proceedings, Vol. II., pp. 657-63.

* This Society's Proceedings, Vol. II., pp. 657-63.

(1) This Society's Proceedings, Vol. II., p. 659; (2) *ibid*, Vol. III., pp. 329-335; (3) *ibid*, Vol. IV., p. 439; (4) *ibid*, Vol. IV., p. 453; (5) This Journal, Vol. VI., p. 276; (6) *ibid*, Vol. IX., p. 142; (7) *ibid*, Vol. IX., p. 427; (8) *ibid*,

absorbtion by mercury of the free gold, and by the plate of mercury. The loss per ton in crushing 7 dwt. gold ore per ton is 1 dwt. mercury. When inside amalgamation is practised in small mills in Rhodesia the losses are known to be high. In many cases where this is known to be the case, not one, but two or more mercury traps of good design should be inserted in the tailings launder. Among the dangers of amalgamation is the fact that amalgam barrels have been known to explode."

A. R. Stacpoole writes[1]: "A large proportion of amalgam and mercury entering tube mills is ground and floured amalgam which will float on the plates and which can be found at water mark adhering to the sides of launders both in the sand and slime plants. It is even questionable whether a portion does not float away on the overflow water from slimes plants."

J. H. Johnson remarks[2]: "Some amalgamators seem to think that once the amalgam is on the plates it requires a charge of dynamite to get it off."

H. H. Johnson and H. F.. Roche state[3] that "15% of the mercury fed to mills is lost."

Modern Practice.—W. R. Dowling states[4] "that the tube mill circuit forms a most efficient mercury trap."

"The popular theory that only 85% of this gold (i.e., fine gold not amalgamated) is recovered by cyaniding instead of 100% by amalgamation is not borne out either in the laboratory by assaying residues or by regular pannings of residues. Any fine metallic gold overflowing the tube mill circuit cones is necessarily smaller and more easily dissolved than the average of partly enclosed particles in sand." He advocates two plates 10½ × 4¾ feet per tube mill, and setting them at an angle of 18 degrees with a density of pulp passing over them 400 sand to 480 water.

W. A. Caldecott writes[5]: "In addition it is possible that some particles of black sand may have their exposed gold surfaces amalgamated while passing over the plate. This gold would be protected from solution and the residues would thus contain undissolved gold."

He speaks of amalgam and gold-bearing mercury eroded from the plates, which take the overflow from the tube mill cones.

W. R. Dowling remarks that all the gold that now passes the amalgam plates must be encased. The approximate present practice with regard to amalgamation is well summed up on pages 75 to 78 and 120 of the text book on "Rand Metallurgical Practice." I understand that shaking plates with a 10° slope have been largely or totally abandoned for stationary plates having an 18° slope, and that from two to three plates per tube mill are employed. Each plate, about 9 ft. × 4½ ft. in size, passes about 5,000 cubic feet of pulp, or 200 tons of sand and 240 feet of water per 24 hours. Such a plate locks up gold to the value of 1 oz. per square foot, or, say, £200 in value. The loss of coarse amalgam in the pulp has now been prevented, and the consumption of mercury reduced to one-sixth of what it was, and the cost of amalgamation is calculated at 2d. per ton, or, say, to 3d. at present wages. At a superficial glance the position of such a process seems an impregnable one, and one has to admit that many of the defects of the process have been reduced in its use on large modern plants on the Rand. I intend, however, to try and prove that the process is an inherently unsound one and one quite unnecessary. As a process in general use, only those who have seen it employed under various conditions and by all sorts of people all over the world, can have any idea of the waste and loss caused by its inherent defects. This loss has only partly been obviated since the adoption of the cyanide process. I might quote instances that have come under my own observation. Not very many miles from Johannesburg a small operator was ruined because ores of bismuth made the amalgam so fluid that the gold rolled off the plate. An inspection of the tailings of a small mine near Bulawayo containing arsenical pyrite in the ore showed a shocking amount of coarse amalgam and mercury in the tailings. While in Victoria, where usually the ores are very free milling and the tailings not worth cyaniding, in places, however, in which canvas strakes were not in use, tributors used to extract mercury and gold from the tailings at a profit. Where the ore was refractory other methods had to be evolved. Amalgamation has held its own in use partly owing to the obvious advantages the process possesses.

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(1) This Journal, Vol. XI., pp. 371-3; (2) *ibid*, Vol. XI., p. 115; (3) *ibid*, Vol. XI., p. 255; (4) *ibid*, Vol. XI., pp. 411-422; (5) *ibid*, Vol. XII., pp. 31-32.

First, in making a clean separation of the gold from the gangue and from most sulphides in one operation.

Secondly, because the method of weighing the daily scrape of amalgam gives an approximate estimate of the grade of ore milled for that period. The majority of Rand metallurgists and others would of course add a third and fourth and, to their mind, the most important advantages thus.

Third, amalgamation is the most effective method of saving the greatest proportion of free gold in the ore.

Fourth, amalgamation is the cheapest method of recovering the free gold in Rand banket ore.

I will now endeavour to summarize the inherent defects of this process and then propose alternative methods. The physical factors involved for separation are the specific gravity of the minerals and of the separating medium—these are gold, say, 19·0, mercury 13·6, iron 7·86, copper 8·5, iron pyrite,say, 5, quartz 2·6, and water 1.

Gold is tough and malleable and in the stamp mill and even in the tube mill escapes comminution into slime in a wonderful way. It is not affected by acids or salts. Mercury is a liquid. In combination with gold in the ores in the right proportion it forms a coherent mass; but if the mercury is in excess it forms globules which are spherical, and tend to roll, so that it is almost impossible to retain them on any surface and the mercury prevents the solution of the enclosed gold in normal time in cyanide solutions. Any two spheres of mercury when floured can have only one point of contact, hence they tend never to unite. If the mercury present is in too small an amount in the amalgam, a most brittle product is the result.

Amalgam of this composition, hard amalgam, is always present on plates. Its removal and handling always leads to great and sometimes unsuspected losses. One has only to refer to the recent discussions on steaming plates and the references made by several members and by Mr. George to get some adequate idea of the state of things that exists. Not only are these two dangers ever present, but by introducing mercury, which is a metal liable to attack by various salts found in the ores, the danger of loss is greatly increased. I submit therefore the proposition that if it can possibly be avoided the introduction of mercury should on scientific grounds be avoided. It is only the safeguard afforded by the use of the cyanide process in the mills on the Rand that prevents very large losses due to sickening and flouring of mercury in the tube mills. As already pointed out, possibly on the Rand and certainly elsewhere large losses are caused by the escape of amalgam and mercury in large lumps which go right through the cyanide plant. In the launder leading to the cyanide plant of the Agnes Mine at Barberton several ounces of such amalgam were plainly to be seen on a recent visit. Mines not employing tube mills and return cones depend for the prevention of these losses on the very crudest kind of gravity concentration devices known as amalgam traps. It is just as wicked a practice to put mercury into a tube mill, as it is to put it in a stamp mill, a practice, I believe, now discarded on the Rand. The above-mentioned are not however the only objections or the gravest objections to the use of this process. There is the grave objection that under the circumstances in which many of the mines of the Rand operate, and owing to the impossibilities of judging by inspection exactly how much gold is on the plates; that when a poor month occurs and a second scraping, or extra severe steaming is ordered from "those in authority," the maximum gold saving efficiency of the plates may be, and is often, seriously impaired. We have already noted as a grave defect of the process that in starting up a new mill or using a plate after scaling returns are upset for a considerable period, and no doubt losses are caused owing to the gold saving quality of the plates not being properly developed. Yet another objection arises from the fact that a large amount of money is locked up and the interest on the money is lost owing to the use of this method. One ounce of gold to the square foot of plate represents the loss of a large sum of money in a large mill, and when our metallurgists tell us that amalgamation is a process near perfection, because it costs only 2d. or 3d. per ton, they neglect this item among other sources of expenditure. Again, amalgamation as practised in the mills of the Rand is a wasteful, dirty process that should not for a moment be endured if a substitute for it can be found. One has only to ask where the tens of thousands of pounds worth of gold recovered from the old mill sites of the Rand came from and how much the loss of interest and cost of recovery of these sums can be charged against the employment of amalgamation?

Further, amalgamation creates a number of bye-products requiring treatment. Amalgam is caught in sieves, dies, magnetics, screens and packing, and these need tedious and expensive treatment, which would be unnecessary if the gold were left free.

As to the dirtiness of the process as practised to-day in our model mills, I again draw attention to the remarks of Mr. George and others in the recent discussion on steaming plates. I also quote from the "Star" of November 29th, 1919. Sworn evidence given in a very sad case tried at Benoni. "Accused had a scraper in his hand and then got down on his knees underneath the plates. He appeared to be scraping below. Witness was asked to explain how the gold amalgam was on the ground. Witness said accused's duty is to scrape the table plates when on afternoon shift and dressing them on night shift. The plates are brushed first with a hard broom with short handle. The broom is "bumped" on the plates, the amalgam sticking to the broom. The amalgam, after being bumped on the plates is collected with a smooth brush into a dish. The hard brush will hold from one to four ounces of amalgam. In knocking the amalgam out it is easy for it to fall on the ground. Specks could be seen all over the place; but in accused's section the floor was saturated with amalgam." If this be the state of things in one of the big mills of the Rand comment is needless.

It is needless for me to comment on the danger to health caused by the use and abuse of this process. The discussion on steaming plates has emphasised this.

The process has however another final and fatal objection. It is an immoral process. Its use places constant temptation in the way of men who are not safeguarded by status, and often not by education and training to withstand it. I have had a few glimpses behind the scenes lately and "I could a tale unfold to make your flesh creep." There is no doubt that a certain percentage of gold often does not find its way into the safe of the Mill Manager, and this charge places a heavy debit against the use of the process. The moral consideration however outweighs all others; as the story of many ruined lives shows, and weak souls have the right to pray "lead us not into temptation." The retort to all this of course is that no better process is known and amalgamation cannot be dispensed with. My reply to this is first, that in many instances the process has been dispensed with with great success. Second, that from the very nature of the problem it is obvious that it is to be solved by the application of the simplest principles of wet concentration. Let us note *first* that according to the authorities quoted the prime essential for successful amalgamation is and must be that the particles of gold are of such size and shape as to be able to bring their superior specific gravity into play and thus come in contact with the mercury surface presented to them. We have noted however that many other factors may enter in and prevent amalgamation.

With concentration; specific gravity, size and shape are the only factors that count, adverse chemical factors and most adverse mechanical factors are eliminated, and if a particle of gold can be saved by amalgamation it can be more surely and more easily saved, given suitable apparatus, by means of wet concentration.

Wet concentration.—Particles of different specific gravity falling freely in a fluid are separated by the difference of their velocities of fall. Rittinger's equation for particles of average shape is: Velocity of fall in water= $2{\cdot}44\sqrt{D\ (\text{sp. g.}-1)}$, where D=diameter of particle. The velocity (squared) of falling for the various minerals and metals concerned is thus:—

For gold $V^2=5{\cdot}9536 \times D\ (19{\cdot}3 - 1)$
For quartz $V^2=5{\cdot}9536 \times D\ (2{\cdot}6 - 1)$
For pyrite $V^2=5{\cdot}9536 \times D\ (5{\cdot}0 - 1)$
For iron $V^2=5{\cdot}9536 \times D\ (7{\cdot}86 - 1)$
For copper $V^2=5{\cdot}9536 \times D\ (8{\cdot}5 - 1)$

and $\dfrac{D_1}{D_2}=\dfrac{\text{Sp. g.}_2-S}{\text{Sp. g.}_1-S}$=Equal falling ratios.

(S = Sp. g. of the fluid, i.e., 1 in water).

It is thus apparent that a particle of gold will have the same falling rate ratio as that of a particle of quartz 11·2 times its diameter, or of pyrite 4·51 its diameter. Where the liquid is denser and where the settling is hindered, as in a thick pulp or in a rising column of water, these differences are accentuated. Amalgamation practice has proved that under the conditions existing even where plates are placed directly in front of mills crushing as coarse as 30 mesh there is no particle of gold that has mass great enough to settle in water that will not reach the lower layers of the sand stratum moving over the plates. Where plates are set below tube mills which make a pulp of this approximate composition.

Say – 40 + 60 diam. = 0·01″ 8·4%
+ 90 diam. = 0·06″ 33·3%
+ 200 diam. = 0·03″ 46·3%
– 200 diam. 12·0%

It is highly probable that only a very few grains of pyrite are large enough to compete with the finest "settling" particles of gold in the pulp. What the diameter of the finest particles of gold is that cannot be called slime gold has never, I think, been determined by experiment; but anyone who does any amount of panning cannot help having often wondered at the extreme fineness of the particles of gold which often form the "tails," and at the ease with which they are separated from the very much coarser particles of pyrite or galena, or even from the iron from the mortar.

It is, then, obvious that any gold that can reach the amalgamated plate can be equally well saved by means of concentrating devices, provided these are properly designed for the conditions under which they must work. If further proof of this simple axiom is needed, it is to be found in the facts which I laid before this Society some years ago and have referred to since. In plants all over the world amalgamation has been dispensed with to advantage. Twenty years ago, when the mines of Ballarat East, Victoria, were working, the manager of the Llanberris Mine never used amalgamated plates. The quartz contained but little sulphides, and he used a cast-iron table, hinged centrally, so that it could be tipped into a concrete pit below it. Its construction is shown in the accompanying diagram, Fig. 1. No free gold could be panned from the tailings after the pulp had also passed over blanket strakes put in to recover some of the sulphides. As there were few sulphide particles to fill up the eddies and pockets, it was some time before the gold worked down to the bottom of the table, and when it did so the pulp was turned off, a little clear water run over, and the plate tipped. The concentrates were subsequently amalgamated in a barrel or Berdan pan. In the Ravenswood Gold Fields in Queensland, and the Costerfield Antimony Mines in Victoria, the pulp contained so much sulphide ore, which caused sickening of the plates, that amalgamation was entirely abandoned, and it was found, as might be expected, that passing even unclassified ore from the stamp mill over Wilfley tables, it was perfectly easy to get a clean streak of gold concentrate off the table, followed by middling of sulphides for roasting and other treatment. When, however, any mechanical concentrator is employed there is a risk of breakdown, and some safety devices such as blankets strakes must be installed below. In the proceedings of this Society I have already recorded instances of how effective a properly designed installation of canvas tables can be in saving gold that can only be called slime gold. At Johnson's Reef G.M. Co., in Bendigo, I have seen gold saved that had passed over the plates, and so fine that when shaken with water it took several minutes to settle. The best surface of any, however, for saving gold of average fineness is a bed of "live sand," and the only problem to be solved in dispensing with amalgamated plates is to provide such a surface at a minimum expense and supplement it when necessary with blanket, corduroy or canvas tables of adequate area within the space available. The problem confronting the Rand metallurgist who would endeavour to eliminate amalgamation separates itself into three heads:—

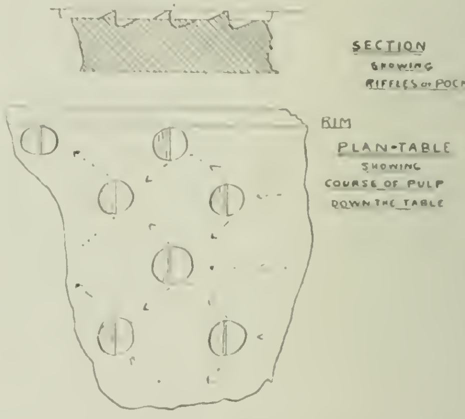

Fig. 1.
Cast Iron Table used at the Llanberris Mine.

First, those mines having plates still in use in front of the stamps, and perhaps plates following tube mills.

Second, those mines equipped entirely with ante-tube mill plates in a plate house.

Third, unequipped mines requiring a new plant.

Dealing first with No. 1. It has already been proved that it is quite possible to catch all the gold liberated from the semi-coarse crushing of stamps. This is, I believe, now being done at the New Goch Mine on corduroy strips laid on the old tables. On the Giant Mine, Rhodesia, all gold was recovered on blanket tables. The washing and replacement of these, however, involves a lot of unnecessary labour, and an adaptation of one of the devices to be described would save all the free gold and possibly some pyrite before reaching the tube mills. In those mills that have shaking tables erected below the tubes, I am of opinion that a very satisfactory bed of live sand could be obtained by placing a number of quarter-inch "slats" (about three inches apart) on the table and re-installing the shaking device. The results would be quite as satisfactory as in amalgamation practice, especially if room could be found also for a few feet of the arrangement of canvas tables elsewhere described. (See Proceedings of this Society, Vol XI., p. 258.) This arrangement, however, suffers from the defects of power consumption and wear and tear. Other practical ways remain for making a settlement and separation for the gold and heavy concentrates. One is by means of an upward current separator and the other is by stirring up the sand by a small vertical downward jet of water or air. The first method dilutes the pulp to a greater degree and adds to the expense of re-elevation. It is, however, possible, by properly designing the apparatus, to extract a very concentrated gold, iron, copper, coarse pyrite product from the closely sized product leaving the tube mills. The other method uses less water, but yields a somewhat more bulky product. I consider that the best results might be obtained by combining both methods. The apparatus proposed would have approximately the same width as the present amalgamating tables. Preferably it should increase in width at the lower end, and as less room would be required around it, it could be made thus. The length would not need to be greater and would probably be less than present tables, and the slope would be probably

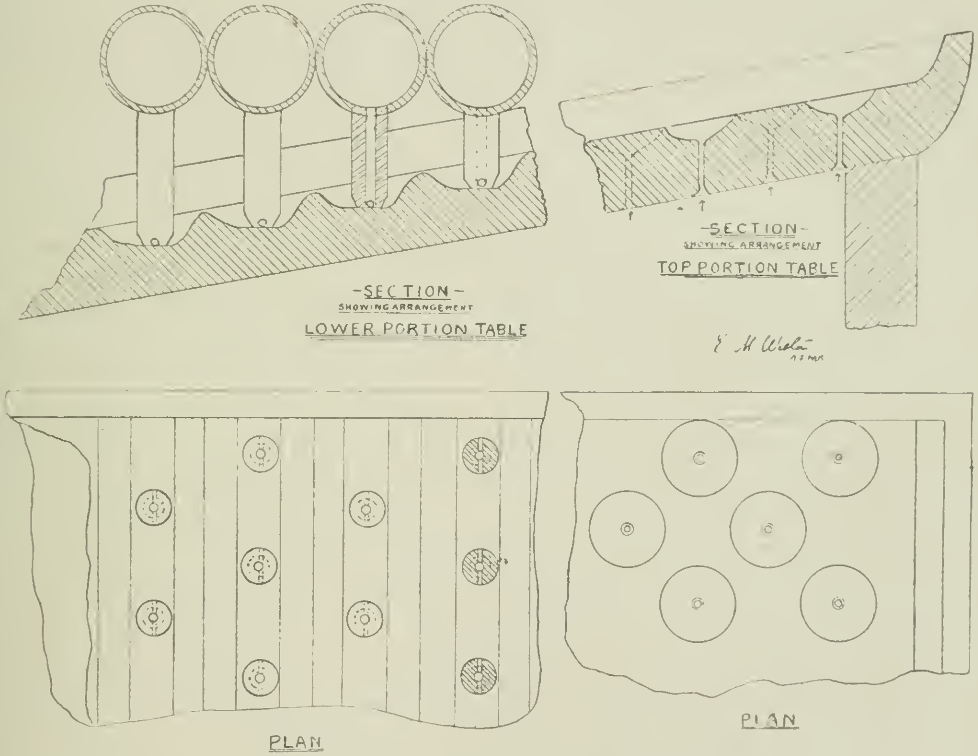

Fig. 2.
Cast Iron Table used at the Llanberris Mine.

12 degrees. The top portion of the table would be about 12 inches long, and divided into two or three compartments longitudinally to allow of control of the water supply. There would be three castings having a surface of two feet by one foot each. These would be covered with a tightly-fitting bronze cover about one inch thick. This would be pierced with a series of holes about $\frac{1}{12}$in. diameter, spaced two inches apart across the table, in rows one inch apart down the table. These holes would be staggered in alternate rows. On the surface of the table each hole is expanded into a cup-like depression about one inch in diameter and about one-quarter inch deep. Water under pressure is supplied to each section of the table converting the holes into so many hydraulic sorting columns, ending in areas of "boiling sand" at the table surface. The pressure is regulated to give the grade of concentrate required. The draw-off cocks at the foot of the table are to be of special construction and securely locked. The remainder of the table would have a corrugated surface with corrugations having a width of about one and a half inches, but of about half the height. Over the troughs of these corrugations are to be arranged small tubes having a bore of about $\frac{1}{10}$in. with two lateral deliveries. These tubes would be fed with water or air under slight pressure from pipes, or portable trays arranged in such a way as to be removable, but, when in place, to render access to the plate impossible. These pipes would be arranged about 1in. to 1½in. apart and staggered in alternate rows. They would keep the sand and concentrate in the troughs "lively" and present an ideal settling surface for the gold particles. It might be found advisable to draw off the bulk of the coarse gold at once as soon as it leaves the tube mill by inserting in the launder a small "spitzluten" with a long sorting column of quarter-inch pipe, or less, and with a strong rising column, and to deliver the concentrate direct to a locked receptacle. Assuming that this simple apparatus will retain all the gold that amalgamation does to-day, but in the form of a mixed concentrate, the question arises as to the best method of cleaning up and of obtaining retorted gold. The gold on the tables is, of course, easily brushed down and collected with the concentrates, and this need only be done in the presence of responsible officials once or twice a day. All other gold-bearing concentrate remains in locked receptacles until it is removed for treatment. The gold is not in a form making theft easy. Two or three separate methods are available for further treatment, depending on the power and room available. What proportion of pyrite it is wished to save for its sulphur value, and other minor factors, would need consideration. A concentrating table of the Wilfley type would deal with all the concentrates without further trouble, giving, first, a fine gold concentrate ready for smelting; second, a middling of gold, iron and copper particles. This could be treated by the magnet to remove iron and by acid to remove the copper, and would then be smelted with No. 1. Third, tailing, consisting of pyrite and sand. This might want re-dressing, and would then be sold for its gold and sulphur contents or cyanided. Another method of separation would be the close sizing of the concentrate on screens of 40, 60 and 90 mesh, followed by hydraulic separation of the fine gold concentrate in hydraulic concentrators, made with glass tube rising columns. Another method would involve the use of mercury to separate the gold in a barrel or pan. This, however, should seldom be recommended. It would take up unnecessary space at this stage to reply to the objections that will be brought against these schemes on the score of dilution of pulp, ineffectiveness, cost, and other items.

I am of opinion that perhaps the final form the substitute to amalgamated plates will take will be a table with removable riffles and having a porous bottom through which air is forced to keep the sand and pyrite lively.

I have not enumerated the economies and advantages that would follow from such a change in metallurgical practice. They are self-evident. The only reasons they have not been secured before has been the inertia of custom, the Rand metallurgists' pride of achievement, the lack of practical knowledge of concentration problems in Africa, and a delusive and erroneous estimate of the real costs of amalgamation to the industry. The real bankruptcy of metallurgical thought on the Rand on this subject is shown in the recent announcement that the Consulting Engineer of the Van Ryn Deep, Ltd., has recommended that, because the grade of the ore has increased and the tonnage milled had slightly increased it was necessary to increase the plate area 50% in the mill!

Why should our metallurgists complacently view the loss of the sulphur contents of the ore?

Mr. J. M. Neill (*Member*): I would like to move a vote of thanks to Mr. Weston for his paper. It will probably cause a lot of controversy. The author will have a good deal to reply to in regard to a number of the statements made. The cost of the scheme advocated is also likely to be heavier than warranted by any expected gain. One thing that strikes me is the omission of the acknowledgment of a fact that was proved many years ago. I think it was Skea, as the Geologist in New Zealand, who observed, and Rossiter W. Raymond in America who, in 1870, proved, that small particles of metallic minerals had the power to attach to themselves quantities of air and, therefore, to float. Any scheme that would employ air to keep in motion a volume of pulp, no matter how shallow it may be, would have a tendency to float the metallic particles because of their lustrous surfaces, and so defeat the object the author has in view. During 1904 to 1909, at the old Jumpers Mill, I was using plates, canvas and deflotation, with the result that 71% of the gold was recovered in the mill as against about 50% previously obtained. A paper on the subject was published by myself in 1913, entitled "The Recovery of Black Sand and floating particles of Metallic Minerals.."* A perusal of this, as well as of other papers and extracts that have appeared in the *Journal* from time to time, should help Mr. Weston to a belief that other workers have had thoughts along lines similar, if not so advanced, as those for which I now ask you to thank him.

Mr. John Watson (*Member*): I have much pleasure in supporting the vote of thanks to the author. Having been out of the gold industry some 16 months, I feel rather diffident about discussing a paper on this subject. When I first came to the Rand in 1896, there were quite a lot of frue vanner concentrators running. I think they mostly have been scrapped now; but for some of the ores found in Rhodesia and other parts of South Africa one has seen Wilfley and other concentrators in use. The daily scrape of amalgam gave an immediate return; while concentrates were shipped in some cases to Swansea.

We have had papers of this kind repeatedly before this Society since the time of Mr. Franklin White, and the general consensus of opinion has always been that the use of the amalgamated plate is the most convenient way of catching some 60% of the gold, leaving the other 40% for the cyanide process.

I have no doubt that Mr. Weston's paper is one which will evoke considerable discussion

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* This Society's Journal, Vol. 13, March, 1913, pp. 418-421.

MEANS ADOPTED ON THE NEW GOCH GOLD MINE FOR REDUCING THE CONSUMPTION OF MERCURY.

By H. J. Lee (Member).

I have been asked to prepare a few notes on the methods adopted and precautions taken to combat the heavy loss of mercury usually associated with the recovery of gold by plate or barrel amalgamation.

It may be interesting to note that on the New Goch, for the year preceding the adoption of the system under review, the average loss of mercury was 0·10 oz. per ton of rock crushed, or 0·7 oz. per oz. of fine gold recovered. The total gold recovered by amalgamation, over twelve months, was 62·5%. This was in the days when the full mill of 120 stamps and four tube mills were running, and the product passed over 38 amalgamated copper plates, a total area of approximately 2,060 sq. ft. The mill plates were dressed every eight hours and the tube mill plates every four hours. With the value of the ore under 5 dwt., and crushing with a screen of 100 mesh 25 gauge, it will be readily seen that the plate area was far in excess of the requirements.

A considerable amount of mercury was consumed each shift in an abortive effort to keep the mill plates in condition, and even then, only about 30% of the copper plate was really amalgamated. The greatest loss of mercury was from the mill plates, and, as will be shown, a big saving was effected by finally removing the plates from the mill and introducing corduroy as a concentrator in their place. To-day, with a lower grade, with all the copper plates removed from the mill, and only running 12 tube mill plates, with a total area of 540 sq. ft., the loss is only 0·01 oz. mercury per ton crushed, or 0·3 oz. per oz. of fine gold recovered.

Concentration with Corduroy.—Experiments with corduroy have been made to determine the area giving the greatest efficiency. The best results were obtained from two widths of cloth, or roughly 23 sq. ft. of corduroy to every 5 stamps. No doubt, given a better grade of ore, it would pay to cover the whole of the table. The ratio of water to ore is considerably increased when corduroy is used, and unless there is a plentiful supply of water (say, at least 7 to 1), the accumulation of a lot of unnecessary sand for treatment will result. The fall of the mill tables is about 9%, but if the fall can be increased, less water will be required. The corduroy is washed every twelve hours and renewed about every six weeks; even a longer life may be obtained, but from observation I find the corduroy becomes hard, crusted with pyrite, and less efficient as a concentrator. It may be interesting to state the small running cost for material. In over twelve months, the total consumption of corduroy was only 74·5 yds., costing £17 15s. 10d., or 0·02d. per ton crushed. This also includes the corduroy in use on the tube mill tables, to which I will refer later.

Amalgamation in Barrel.—Roughly, our accumulation of mill concentrate averages about 300 lb. per day. A charge of 600 lb. is put in the clean-up barrel, together with a grinding charge of 30 stem ends weighing approximately 500 lb., the ratio of water added being 1·5 to 1. The speed of the barrel is 25 r.p.m. This is ground for 8 to 9 hours, according to size of charge, after which sufficient mercury to establish a real liquid amalgam is added, and the grinding continued for another hour. In cleaning out the barrel, and for separating its contents, a batea is used; the period of agitation here is only about 30 minutes, and the loss of mercury both in grinding and cleaning up is very small indeed. It seems to me that quite a number of millmen make a great mistake in grinding too long with mercury. Except with a large quantity of amalgam in a small ball mill, I would never advocate running with mercury for more than one hour. With all heavy sands, such as mercury trap and die sand the amalgamation in the barrel should be reduced to 30 minutes. I may mention an instance when grinding die sand, as an experiment, for 10 hours with mercury, the loss of mercury was 60 oz. out of 200 oz. in use, exclusive of that taken up by the gold.

Recovery by New Method.—The total recovery by amalgamation is now 63·4%, of which 22·9% is recovered from stamp mill concentrate—proving at least that the recovery has not suffered by the change. The average loss of mercury in treating the concentrate is only 64 oz. per month, or 0·004 oz. per ton crushed.

Plate Amalgamation.—Amalgamation is carried on with 12 plates in the tube mill house. The loss of mercury here has been reduced by a decrease in the number of times dressed, without any loss in actual recovery. At present the plates are dressed every 8 hours, while in the past dressing every 4 hours was the rule. At the bottom of each plate a piece of corduroy, about 10 sq. ft., is used, which acts as a concentrator, and also prevents a certain amount of mercury from leaving the plate. The concentrate from this source is treated in the same way as the mill concentrate, except, owing to their poorer value and the fact that much iron is retained by the corduroy, it requires longer grinding. This, by the way, is an excellent means of removing iron and pyritic accumulation from the tube mill circuit. The tube mill plates are stationary and have a fall of 17%. A certain amount of mercury must still be escaping from these plates, but in a period of twelve months, only 107 oz. of amalgam has been recovered from the launders, which rather points to the fact that the mercury released is not in amalgamable form.

Suggested Elimination of Plate Amalgamation.—There is no doubt that the poorer the value of the ore, the greater the loss of mercury wherever amalgamation is carried on. It would be most interesting to know how far corduroy could be utilised in connection with, or as a substitute for, plate amalgamation. Personally, I think it is quite within the range of possibility to discard all amalgamation, except in the clean-up room, without materially affecting the mill recovery. Apart from the great saving in mercury (and one must also associate a certain loss of gold with mercury), it would also remove any temptation to theft, except in the clean-up room. The loss of mercury would then be reduced to a minimum, while there would also be a slight loss in grinding and the usual 2 to 3 % in retorting, certainly, in all, not more than 0·01 oz. per ton.

Mercurial Poisoning.—Steaming has been dispensed with on this mine altogether, without in any way reducing the maximum output from the monthly clean-up. If I may venture an opinion with regard to steaming and its ill-effects, I certainly think, and I have heard doctors propound the same theory, that the possibilities of mercurial poisoning are far greater in the clean-up room, where one is continually *handling* mercury, than from the effects of fumes in steaming and retorting. Millmen generally cannot be too careful when cleaning up amalgam, especially if suffering from even a slight abrasion of the skin. My advice is to protect the skin from contact with mercury in any form.

I have strayed somewhat from the subject under review, but there are so many matters which have some bearing on the question of mercury.

In conclusion, may I suggest that one of the richer mines should take up the question of the total recovery of mill gold by concentration on corduroy, in so far as the stamp and tube mill recovery is concerned.

Mr. E. M. Weston (*Member of Council*): I beg to propose a vote of thanks to the author for this paper. I consider it a very timely one.

Mr. J. M. Neill (*Member*): I beg to second that vote of thanks. The only discussion that could arise here would be confined to the point that flotation does take place. This affects lustrous gold carrying mineral to such an extent that it goes into the slime circuit; and, therefore, deflotation must be provided for, or flotation entirely adopted.

The cost of this latter process is at present too high to warrant our serious consideration.

Some years ago, on Brakpan Mines, the stock vat for Butters' filter, owing to lack of slime, was run empty at times, and the last charge treated gave the highest residue. Talking from memory, when the residue was generally about 0·1 to 0·15 dwt., that last charge went up to about 0.5 dwt. residue; so there were present particles of gold carrying mineral not amenable to plate recovery or cyanide treatment. These particles had probably floated over into the furthest circuit of the plant, and there, owing to slowness of movement and loss of lustre, sank, and went out with the residue. Because this paper is along correct lines, I have much pleasure in seconding the vote of thanks, at the same time expressing my belief that the copper plates must be retained.

NOTES ON DEFECTIVE AIR IN DISUSED RAISES AND BACKSTOPES.

By C. J. Gray (Member of Council).

(Printed in Journal, May, 1919.)

REPLY TO DISCUSSION.

Mr. C. J. Gray (*Member of Council*): I wish to thank those who have joined in the discussion on my paper, both for the value of their contributions and the gentleness of their criticism. To Dr. Irvine I am particularly indebted, despite my unwitting omission to acknowledge his prior reference to a fatal occurrence of black damp in a raise. The views he expressed are in harmony with mine, but he may think it worth while to consider whether or not proportions of black damp which would be quite insignificant in collieries are important on the Rand. In connection with his reference to the effect of fire damp, Dr. Irvine may be interested in the fact that in June, 1899, a native, when climbing over a fall in the New Campbell Colliery in Natal, was asphyxiated in an accumulation of fire damp in the cavity left by the fall.

Two members objected to use of the term "black damp." It happens that I used it only in connection with readings of Haldane's tube, which is graduated for black damp, but I do not agree that the term is objectionable. It is an old and well-known English mining term for which there is no equivalent.

It would be awkward to speak of "oxygen deficiency" flowing or filling excavations, as black damp does.

Mr. White may be correct in considering the deficiency of oxygen observed in disused raises and backstopes to be due to oxidation of pyrite, but to my mind the point is not definitely settled. Oxidation of pyrite would not increase the normal CO_2 percentages even to the amounts found in the analyses, and CO_2 would not gravitate into raises. One would think that oxidation of even a very thin layer on the side of a raise would be obvious to the eye, and that deoxidation of the air could not be rapid enough to gain markedly on air circulation and diffusion. If it were so rapid, the temperature should rise sharply. I recognise, however, that if once the air in a raise, through oxygen deficiency or heat generated by oxidation of pyrite, became markedly lighter than the air at its entrance, circulation would almost stop, and that diffusion alone is of little consequence in ventilation. The matter requires further investigation.

Mr. Woodburn's idea that air containing excess of nitrogen may have risen into the raises, is unlikely to be correct in the particular circumstances. The places examined were not in parts of the mines where great variation in the composition of the air current would be expected.

With regard to Mr. White's suggestion that sulphuretted hydrogen may have been present, I would say that there was no smell of it in the places I examined.

Mr. Chilton considered it possible the oxygen deficiency in the Wolhuter accident was due to methane. I would remind him that ordinary open lights were extinguished without first causing an ignition, and that analysis showed the percentage of CO_2 to be too small to prevent ignition of fire damp. The analyses, and the fact that the accident occurred in a raise, sufficiently dispose of his alternative suggestion that an outburst of CO_2 was the cause.

One or two of those who contributed to the discussion did not seem to understand clearly that I did not attribute the deaths to CO_2. I thought there would be no room for misunderstanding when they read the paper over at their leisure. It came as a shock when, in an abstract of the paper, I found the statements: "It is not generally realised that, owing to possible accumulation of carbon dioxide, precautions should be taken when entering disused raises and similar places in Witwatersrand mines," and "Further investigation showed that disused raises and backstopes in various mines contained lethal quantities of carbon dioxide." Evidently it was possible to misunderstand most seriously. I wish to say that I have no reason to think that carbon dioxide ever occurs in lethal quantities in disused raises and backstopes. The danger is from deficiency of oxygen, which, presumably, entails excess of nitrogen, the amount of carbon dioxide being small.

Perhaps I may repeat the paragraph in the paper containing my main conclusion. It was:—

"From the foregoing it may fairly be concluded that frequently, if not always, the percentage of oxygen in disused raises and backstopes falls below that in normal air, and that occasionally it becomes so low that lights will not burn, and, in extreme cases, that persons cannot live in those places." The last words were: "The observations, therefore, emphasise the need that mine officials be not content with carbon dioxide analyses and dust determinations, and satisfy themselves that the oxygen supply is everywhere sufficient."

THE SOLUBILITY OF GOLD IN CYANIDE SOLUTIONS.

By H. A. White (Member of Council).

(Printed in Journal, July, 1919):

REPLY TO DISCUSSION.

Mr. H. A. White *(Member of Council):* I have to thank the contributors to this discussion for their kind remarks, but as no disagreement with the conclusions arrived at was expressed, no further reply is called for. That so little discussion was obtained may fairly be attributed to the fact that the paper was practically confined to reports of experiments and logical deductions therefrom.

HANGING WALL SUPPORT ON THE FAR EAST RAND.

By L. W. Macer (*Associate*).

(Printed in Journal, October, 1919).

DISCUSSION.

Mr. C. J. Gray *(Member of Council):* The main point to which I wish to draw attention is that very careful study should be given to the hanging wall in the particular mine being dealt with; for there is no general rule for dealing with hanging wall pressure or movement which will apply to all conditions. The immediate hanging wall may be thick and solid, or it may slab off in thin layers. There may be a mine in which there are large excavated areas separated by large or small unworked areas, or one in which nearly the whole of the reef is taken out. There are also great variations in depth. So, although one particular method may be very suitable under particular conditions, it would be a great mistake to assume that it will be suitable elsewhere.

There is one point in connection with pigsties which should be considered. The ordinary pigsty allows for the settlement of the hanging wall without actually breaking; but the amount of settlement which it will allow in some of the deeper mines is so great that there is very serious shearing of the hanging wall along the face: the result in some cases being that it is impossible to continue work, and the stope is lost. In order to get over that difficulty, managers have been obliged to leave pillars despite their dangers, even in the deepest mines with the greatest pressure, recognising that such pillars will uphold the hanging only temporarily The problem is one which will have to be dealt with. What is needed is an otherwise satisfactory pigsty which is more rigid than the ordinary one; but such has not yet been designed. If it were possible to mix sand with the stone used in filling the pigsty, greater rigidity would be obtained, but sand for such a purpose would be rather awkward to handle, and, so far as I know, has not been used on the Rand.

A GENERAL REVIEW OF THE ECONOMIC RESULTS ATTENDING THE GOLD AND BASE METAL MINING IN THE PRETORIA INSPECTORATE DURING THE PERIOD 1904 TO 1914.

By Tudor G. Trevor (*Member*).

(*Printed in Journal, October, 1919*).

DISCUSSION.

Mr. A. C. Alcock, Assistant Chief Inspector of Taxes, Somerset House, London (contributed): I submitted Major Trevor's paper to Dr. Stamp, who comments as follows:—

"It is an exceedingly clear and striking statement of facts presented in a way that is quite new to me.

"With regard to the concluding paragraphs relating to the economic principles involved in gold production, I can only say that I agree very substantially with the suggestions put forward. Gold, of course—apart from its use in the arts—has very great value, because it is so suitable a means of currency, and is universally recognised as such, even though we only keep it in reserve as potential currency. Nobody knows what would be the value of gold in the arts if the whole supply were thrown in that direction, and it were no longer used or usable as currency, but it would obviously be very much less, and a great many gold mines would be unprofitable to work. But since the world has chosen to value gold for its currency uses, Major Trevor's contention that you cannot merely look at the results or margin of profit to a particular agent in the production, viz., the shareholder, is quite right. The industry ought, of course, to pay the proper economic reward or inducement for labour, superintendence, pure interest, risk and maintenance of capital. Those fluctuating rewards beyond this, modern economic teaching says, should be kept to a minimum, and profits of that character, under competitive conditions, are temporary only. It is in the interests of the whole community that their aggregate amount should be as small as possible, and they should be as temporary as possible. This is a very hard saying to business men and those who are out for the prizes in a lottery like gold mining, but in a general sense, it is true. It does not appear, however, that so far as South Africa is concerned there is on balance any such profit, and, in the long run, the whole of what has been made would be required to keep capital flowing into the industry. It does not follow, of course, that because the capitalist has lost the State has lost; it has got the product, and is the richer therefor, but if the loss of the capitalist encroaches upon that reward which was a minimum to induce him to enter, and not merely upon the uneconomic surplus of lottery gains, then the capitalist will be frightened for the future, and the State will not have gained in a dynamic sense as much as would appear."

I may say that Dr. Stamp is one of the foremost economic thinkers in this country, and possesses more than a national reputation. You will no doubt be interested in what he says.

Dr. W. A. Caldecott *(Past President)*: The thanks of the members of our Society, and of the whole mining community, are due to the author for the striking and concrete case which he has presented of the benefits of the basic industry of mining to the whole of South Africa.

In reference, however, to the hypothetical case of "A" and "B," the author appears to have overlooked the fact that when both are citizens of the same country the State is actually poorer for the digging of a useless hole in the ground. This is because the stock of currency in the country remains the same as before, whilst labour has been expended without benefit to the community, and the food, clothing, stores and implements consumed by "B" during the digging operation are taken from the stock in the country without return beyond keeping "B" alive, which could have been done with fewer commodities

Similarly, taking the State as the general community in the author's next illustration, the £1,000 of gold produced is not added wealth to the State, because there has been £1,000 worth of services and commodities consumed in its production and hence the total wealth of the State remains unaltered

The Secretary: The resolution passed at the November meeting of the Society reading:

> "That the Chemical, Metallurgical and Mining Society of South Africa earnestly requests the Government to provide the necessary funds for the training and maintenance of suitable returned soldiers and phthisis men as prospectors, under the direction of the Government Mining Engineer,"

was duly submitted to the Minister for Mines (the Hon. F. S Malan), who was also informed that "there seems to be no doubt that there are vast areas of South Africa awaiting development, and if a number of suitable returned soldiers and phthisis men, of whom numbers are available, could be trained as prospectors, their work would in all probability lead to the opening up of the country to the benefit not only of the industry, but of the population of the Union generally."

Copies were also sent to the Minister for Defence (Colonel the Hon. H. Mentz), the Chairman of the local branch of the Governor-General's Fund, and the Government Mining Engineer.

Subsequently an extract from the *Board of Trade Journal*, of the 20th November, was submitted to the same gentlemen. This extract was as follows:—

"A Special Industries Committee has been sitting in New Zealand, and in its report it states:—

"It is clear that this industry (gold mining) has been permitted to drift for many years without any sustained effort being made by the Government to revive and foster it. It should be remembered that no less a sum than £88,000,000 has been produced from our goldfields during the past sixty or seventy years, and your Committee is of opinion that the questions of the maintenance of the industry and its future development are of national importance. The Waihi Mine itself has given, up to the close of the year 1918, returns to the value of over £11,000,000, and it is surely reasonable to hope and expect that other mines of great, if not equal, wealth may yet be discovered in this country.

"Prospecting, as carried on for some years, has proved a failure, and your Committee is of opinion that the Government should equip and send out prospecting parties under the control, where possible, of a man with local knowledge, the whole work to be carried out under the direction of the Geological Survey Department. This Department has been doing valuable work since 1905, but in order that the best practical results may be obtained, prospecting parties under Government control should be associated with the Department's work."

The Private Secretary to Colonel Mentz replied as follows:—

"I beg to inform you that Colonel Mentz has now had an opportunity of going into the question of the training as prospectors of returned soldiers and phthisis men, and I am to say that the matter enjoys his full sympathy and that he intends to discuss it at the first opportunity with the Minister of Mines."

The Acting Secretary for Mines and Industries replied on the 31st December in the following terms:—

"With reference to your letter addressed to the Hon. the Minister of Mines and Industries on the subject of the training of returned soldiers as prospectors, I am directed to state that, while agreeing that the country is in need of properly-trained prospectors, this Department doubts the practicability of employing men as Government Prospectors, as contemplated in the resolution of the Chemical, Metallurgical and Mining Society of South Africa.

"In the first place, as the Mining and Land Settlement Laws stand to-day, Government Prospecting Parties would be obliged to confine their work to unoccupied Crown Lands.

"Secondly, it would be a very difficult, if not impossible matter to exercise the control over such prospectors which would be necessary if any remuneration were paid by the Government.

"On the other hand, it seems quite feasible to arrange a course of training for returned soldiers as independent prospectors, and this suggestion was referred to the Principal of the South African School of Mines and Technology, which was thought to be the only authority which could arrange for a course of this kind.

"In this connection I attach a copy of a Minute by the Acting Government Mining Engineer, from which you will see that a scheme is being prepared for training prospectors.

"An independent prospector would not be confined to unoccupied Crown Lands, inasmuch as it is always open to him to negotiate with the surface owners of land for permission to prospect."

The Minute attached from Major V. P. Swinburne, the Acting Government Mining Engineer, dated 24th December, reads:—

"Sir Robert Kotze informs me that Professors Young and Celliers interviewed him recently in connection with this question, and that they are preparing a scheme of training for prospectors. The question is one that concerns wholly the School of Mines and Technology, and as this Department has no jurisdiction in the matter, all that can be done is to bring it to the attention of the University Authorities. This has been done, and General Beves might be informed accordingly. The School is in vacation until March next year, so that the scheme is not likely to take practical shape before then."

There being no further discussion, the meeting then terminated.

Obituaries.

C. D. LESLIE.

The news that Mr. C. D. Leslie, until recently Consulting Engineer to the Consolidated Gold Fields of South Africa, had lost his life in the railway accident to the Natal train at Sugar Bush Bridge on February 12th, came as a great blow to practically the whole mining community of the Rand. It was a tribute to a vivid personality that no one seemed able to accept the sad fact: it was as incredible as cruel. It was only a few months since he had relinquished the arduous post that he had filled so capably for many years, and had turned with characteristic keenness to the development of his farm. Already private professional business was drawing him into new mining interests and his friends had never seen him in better health and spirits.

Charles Duff Leslie, born 1871, was the son of a Scottish landowner of Suddie, Ross-shire. He came out to this country, and after a few years in the Civil Service of Natal came to the Transvaal and at once associated himself with mining. He soon made himself a master of his profession, and his sound education, fresh acquisitive mind and the varied nature of his practical experience all combined rapidly to place him in the front rank of mining men.

In 1906 when he took over the management of the Simmer and Jack it was realised that a new force was making itself felt on the Rand. It is owing to his work on this mine that he is entitled to be called a pioneer in the matter of greatly reduced working costs. He introduced such an extraordinary increase in efficiency and so organised all branches of the work of the mine as later on gave the low grade mines a new lease of life. Within a year of his coming to the Simmer and Jack he had literally worked a revolution on the property. To mention the outstanding features, a single shift replaced the old double shift without loss of tonnage.

A new native time-keeping system, itself a masterpiece in the art of mine management, was introduced, and with a reduction of working costs to a half there was opened out for the mine a greatly extended lease of life.

It is not long ago that the writer heard Mr. Leslie say that he had always greatly admired efficiency. Efficiency is a word that has been maltreated of late and in connecting it with his work it is well to consider it a little closely. The efficiency that is so often praised and aimed at, the efficiency whose ideal is the machine is not the efficiency Mr. Leslie preached and practised. He was a man of fine capacity and great energy, but these qualities do not entirely account for the wonderful results he achieved. What then was the secret of his success? More than anything else it was due to his love for ideals and the immense value he placed upon human personality. Where ideas and appreciation of ideas in others are absent, one gets the "official" type, and a concern so ruled is doomed to be without initiative and enterprise among its subordinates. C. D. Leslie was full of ideas and seemed to induce them in others. As the world knows, many can use ideas once they are presented, but few can originate them.

His appreciation of personality was an even rarer gift. No man who worked for him ever felt that he was merely a cog in the wheel. He was made to feel that there were required of him character and responsibility, and above all power to give and receive ideas. Most men capable of engaging in such a profession as mining are also capable of responding to such a demand. Their self-respect increases and their value to themselves and to the world increases accordingly.

There is a limit, especially in this profession, to what a man can accomplish without the goodwill of his subordinates. Everyone who worked for Leslie loved him, as a miner remarked the other day. He was able to make all his men feel that it was their own special qualities that were used and valued. This is the gift of the born master of men and was the secret of his power of attaching to himself the affectionate loyalty of his workers. It was, in fact, the secret of his efficiency.

In addition to his virtues he had an exceptional endowment of the graces which rendered his personality as engaging and gracious as it was virile and commanding. By virtue of such abounding vitality combined with a ready imaginative sympathy he diffused his own good qualities of heart and mind among those who worked for him: he diffused his strength, his good spirits, his optimism, his pleasure in ideas and his sense of one's work being a fight and a game—a hard fight against ignorance and waste and a great game with the interplay of ideas and human forces. Professional contact with the man cheered and invigorated and memories of past meetings give one some faint conception of the overwhelming loss his death means to those who shared his private life.

In the ordinary sense of the word C. D. Leslie could not be called a public man, but his life was by no means private. He spent his strength generously, and his mind was always pre-occupied with the public value that was bound up with all his activities. Latterly this fine quality had developed considerably, and in all the projects and plans for his farm the idea of contributing something to the agricultural future of the country was ever to the fore.

He was still young, for so fresh and open a mind could never decline into old fogeyism, and there was still a great career before him in mining, industry and agriculture. The very large attendance of representatives of every section of the community at the funeral showed that the Rand was conscious of having lost one of the finest of its sons.

In 1916, when Vice-President of the S.A. Institution of Engineers, he took the initiative in convening a meeting of representatives of the several local technical societies, which resulted in a Scientific and Technical Committee being formed to assist the Government during the war. This Committee was ultimately amalgamated with the Government Advisory Board, and is now the Government Advisory Board of Industries and Science, a body which has done much useful work for the community. In 1918-19 he was the President of the S.A. Institution of Engineers.

He joined this Society as a member in February, 1903.

W. E. T.

DR. JULIUS LOEVY.

Many of our older members will regret to learn that news has been received of the death of Dr. Julius Loevy, one of our

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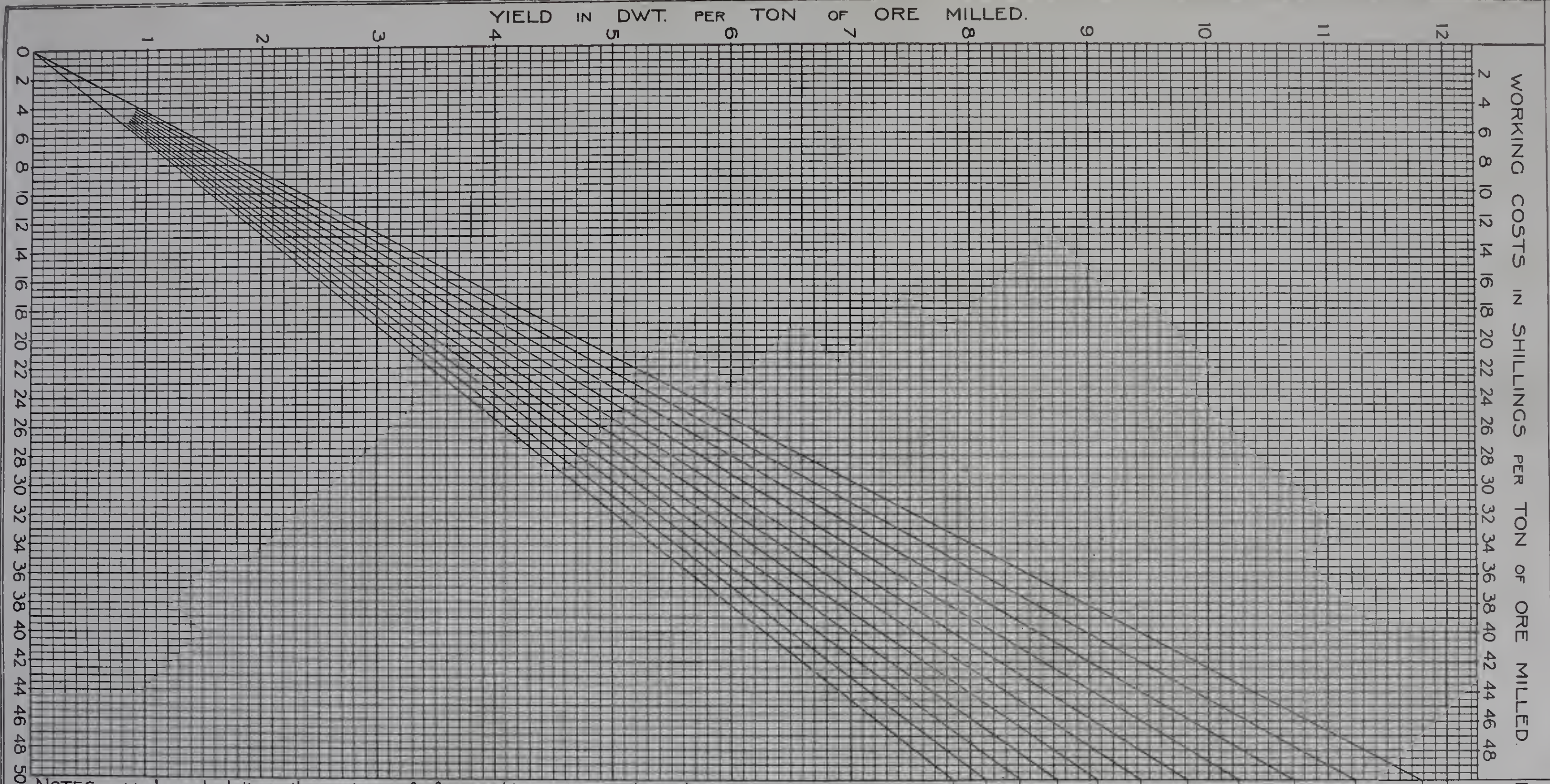
Supplement to
The Journal of The Chemical, Metallurgical and Mining Society of South Africa.
February, 1920.

THE LIMITS OF PAYABLE YIELD OF FINE GOLD PER TON OF ORE WITH PREMIUMS & PRICES OF GOLD & WORKING COSTS AS SHEWN.

BY W. A. CALDECOTT.



PREMIUM ON GOLD	PRICE PER FINE OZ. in Shillings & pence.
0%	84/9·82
5%	89/0·71
10%	93/3·60
15%	97/6·49
20%	101/9·38
25%	106/0·27
30%	110/3·17
35%	114/6·06
40%	118/8·95
45%	122/11·84
50%	127/2·73

NOTES:-
(1) In calculating the prices of fine gold, mint par has been taken as equivalent to 77/9 per standard oz. ($\frac{11}{12}$ fine).
(2) The percentage premium on mint par price of fine gold is equal to:- 1·179 × (current price in shillings per oz. of fine gold) − 100.
(3) The payable limit in dwt. of fine gold per ton of ore milled is equal to:-

$$\frac{23{\cdot}58 \times (\text{working costs in shillings per ton of ore})}{100 + (\text{percentage premium on mint par price of fine gold})}$$

To face page 147.]

3 MARCH 1920

Past-Presidents (1898-9). Before the outbreak of the Anglo-Boer War, Dr. Loevy identified himself largely with the interests of this Society, and his strong personality was revealed in the manner he controlled the "forceful" meetings of those early days. One remembers always his advice to those participating in discussions, *Suaviter in modo, fortiter in re.* During the South African War he left for Europe and pracised first in Berlin, then at Brussels and latterly in Chili.

He was a keen scientist and worthily upheld the honour and prestige of the Society in its early career.

Dr. Loevy was a foundation member of the Society, and largely responsible for the issue of the Society's *Journal*, the first number of which appeared in February, 1898. He was the responsible editor from that date until September, 1899, when its publication ceased temporarily until May, 1902.

A. McA. J.

Notices and Abstracts of Articles and Papers.

CHEMISTRY.

Determination of Phosphorus in Iron and Steel containing Vanadium.—"The methods described below require the following solutions. Nitric acid for titrating: 35·4 cc. of nitric acid (sp. gr. 1·42) diluted to 4000 cc. with distilled water. Sodium hydroxide solution: A stock solution is prepared by stirring 150 gm. of pure sodium hydroxide and 1 gm. of barium hydroxide with 1000 cc. water, decanting or filtering the solution after 24 hours, and diluting with an equal volume of water; the solution for titrating is prepared by diluting 566 cc. of the stock solution to 8000 cc. with water. Ferrous sulphate solution: 55 gm. of steel (low in phosphorus and sulphur) is dissolved in 720 cc. of sulphuric acid (1 : 3), a little water being added occasionally to prevent salting out and the liquid heated gently but not boiled, filtered, cooled, and diluted to 1000 cc. Potassium permanganate solution: 50 gm. in 1000 cc. of water. Nitrate wash: 8 gm. of potassium nitrate in 8000 cc. of water. Acid wash: 102·4 cc. of nitric acid (sp. gr. 1·42) diluted to 8000 cc. with water. Faintly ammoniacal ammonium molybdate solution: Into each of four beakers are weighed 50 gm. of ammonium molybdate and 50 gm. of ammonium nitrate, to which 40 cc. of ammonia solution (sp. gr. 0·95) is added; each solution is diluted to 700 cc. with water; then heated for about 30 minutes with occasional stirring until all the salts are in solution. The contents of the four beakers are united in a large bottle, diluted to 4000 cc. with water, left overnight, and the insoluble matter removed by filtration through double 15 cm. filter-papers but not washed. The clear solution thus obtained should remain clear indefinitely.

I. *Steel containing vanadium up to 2·6%.* 1·63 gr. of the sample is dissolved in 45 cc. of nitric acid (sp. gr. 1·13) over a low flame; when the solution is clear and brown fumes have been expelled, 3 cc. of permanganate solution is added and the liquid boiled for 3 minutes, 3 cc. of the ferrous sulphate solution being then added to dissolve the precipitate caused by excess of permanganate and the solution boiled until brown fumes disappear; large excess of ferrous sulphate is to be avoided. After addition of 40—50 cc. of concentrated nitric acid (sp. gr. 1·42) the liquid is brought to the boil, the cover and sides of the beaker being then rinsed with the least possible quantity of water and 50 cc. of the ammonium molybdate solution added. The whole is stirred vigorously for a minute or two and left overnight, after which it is decanted through a 7 cm. filter-paper with a little paper pulp in the apex, the main precipitate being left in the beaker. Iron is removed by washing 15 times with the nitric acid wash and the main precipitate then introduced into the filter as far as possible with the aid of the nitric acid wash; about 2 cc. of the latter is added to the beaker and adhering particles removed with a rubber-tipped rod, the washings being caught in a separate beaker. The precipitate is washed 15 times with the nitric acid wash and then 25 times with the potassium nitrate wash or until the outside of the filter, especially along the double thickness, has no sour taste. To the washed precipitate, in a 150 cc. beaker, enough of the standard sodium hydroxide solution is added to cause the yellow colour of the precipitate to disappear on macerating the paper to a pulp with a rubber-tipped rod. The volume is made up to about 30 cc. with water and a drop of phenolphthalein added; this should produce a deep red coloration, otherwise more sodium hydroxide solution is needed. The liquid is then titrated back with standard nitric acid solution until the pink colour just disappears. The difference in cc. between alkali and acid solutions multiplied by 0·01 gives the percentage of phosphorus in the steel.

II. *U.S. standard steels and pig-irons to which* 28% *of vanadium has been added; also ferrovanadium containing* 56·7% *vanadium.* 0·5 gm. of steel and 0·5 gm. vanadium pentoxide (56·14% V) are digested in a 250 cc. porcelain dish with a mixture of 30 cc. of hydrochloric acid (sp. gr. 1·20) and 30 cc. of nitric acid (sp. gr. 1·42) for about an hour, the cover being rinsed and the liquid evaporated to dryness with 100 cc. of nitric acid (sp. gr. 1·42). The residue is baked for 5 minutes at 750° in an electric muffle furnace, the oxides dissolved in 35 cc. of concentrated hydrochloric acid, the liquid evaporated to 10 cc., and, after addition of 50 cc. of nitric acid (sp. gr. 1·42), again to 10 cc., and then heated with 10 cc. of concentrated nitric acid with the cover-glass on the dish. The solution is filtered by suction through a platinum Gooch crucible with a thin pad of acid-washed asbestos which is afterwards washed 15 times with a mixture of 200 cc. of nitric acid (sp. gr. 1·42) 100 cc. of water and 20 gm. of ferric nitrate [the ferric nitrate is made by dissolving 5 gm. of melting bar steel low in phosphorus in 50 cc. of hydrochloric acid (1 : 1) and evaporating to a syrup twice with 50 cc. of nitric acid (sp. gr. 1·42) each time]. The filtrate from the separated vanadium pentoxide is concentrated to 10 cc. in a 150 cc. beaker and the second crop of vanadium "rust" filtered off as before; a third concentration to 10 cc. should show no "rust" (V_2O_5). After the third concentration the liquid is brought to the boil with 40 cc. of nitric acid (sp. gr. 1·42) the cover and sides of the beaker being rinsed with water and the liquid percipitated with 50 cc. of the faintly ammoniacal ammonium molybdate solution, the whole being stirred vigorously for about 2 minutes. After an hour the solution is filtered and washed as described under I., titration with alkali and acid being then carried out in the usual manner.

III *Non-vanadium steels or pig-iron.* 1·63 gm. of the sample is dissolved in 45 cc. of nitric acid (sp. gr. 1·13). (In the case of pig iron and certain chrome steels, when all the metal is dissolved the carbon residue is collected on a 7 cm. filter-paper and washed 15 times with dilute nitric acid wash, the filtrate being caught in a 150 cc. beaker and concentrated to the original volume). The solution is boiled for 3 minutes with 3 cc. of the potassium permanganate solution, just sufficient of the ferrous sulphate solution (about 3 cc.) being afterwards added to dissolve the oxides of manganese. The brown fumes are expelled by boiling, 15 cc. of nitric acid (sp. gr. 1·12) is added, the cover and sides of the beaker are rinsed with the least possible amount of water, 50 cc. of the ammonium molybdate solution is added, and the liquid is stirred briskly until the phosphorus precipitate is completely formed (about . minutes). After standing for half an hour or less the solution is filtered through a 7 cm. paper, which is washed 15 times with the nitric acid wash and then with the nitrate wash until the outside fold of the filter-paper has no sour taste; with samples rich in phosphorus 35–40 washings may be necessary. The subsequent procedure is as described above."—C. M. Johnson.—*J. Ind. Eng. Chem.*, 1919, *11*, 113.—*Journ. Soc. Chem. Ind.*, March 31, 1919, p. 179A. (A. W.)

Rapid Determination of Sulphide Sulphur in Pyrite.—"A rapid method of determining sulphide sulphur in pyrite is based upon the fact that the whole of the sulphur in that form is liberated as hydrogen sulphide on treating the mineral with hydrobromic acid in presence of metallic mercury. The ordinary apparatus used for the determination of sulphur in iron and steel may be used. Sufficient mercury (about 20 cc.) to cover the bottom of the evolution flask is introduced, and after the addition of 0·25 gm. of the finely powdered sample, the air is removed from the apparatus by means of a strong current of carbon dioxide. The pyrite is dissolved in 50 cc. of hydrobromic acid (free from chlorine) which is forced into the flask by means of a current of carbon dioxide, the flask being meanwhile gently heated. The hydrogen sulphide is absorbed in 600 cc. of a solution of 25 gm. of cadmium acetate and 200 cc. of acetic acid per litre, or of 20 gm. of zinc acetate, 5 gm. of cadmium acetate, and 200 cc. of acetic acid per litre. After solution of the pyrite is complete, the liquid is boiled for a short time, and, after, removal of the flame, a rapid current of carbon dioxide is passed through the apparatus for at least 15 mins. Fifty cc. of standard iodine solution (197·88 gm. in 10 litres) is then added to the contents of the absorption flask, and, after the addition of 50 cc. of hydrochloric acid (1 : 1), the excess of iodine is titrated with standard thiosulphate solution. Each cc. of iodine solution corresponds to 1% of sulphide sulphur."—A. Bartsch.—*Chem. Zeit.*, 1911, *43*, 334.—*Journ. Soc. Chem. Ind.*, March 31, 1919, p. 171A. (A. W.)

Preparation of Soluble Starch.—"The method of preparing a soluble starch by boiling with alcoholic hydrochloric acid has been studied, in order to fix the most favourable conditions for complete conversion without the formation of more profoundly modified products. Alcohol of 95% strength and hydrochloric acid of sp. gr. 1·19 were employed. Time of treatment, concentration of acid, and proportion of liquid to starch were varied. The highest yield of soluble starch was obtained when 0·75 cc. of strong hydrochloric acid was added to 100 cc. of 95% alcohol and used for the conversion of 20 gm. of starch, the liquid being boiled for 10 minutes with good agitation. The exact quantity of sodium bicarbonate required to neutralise the acid was added at once and the product filtered off, washed with alcohol, and dried. Under favourable conditions it is possible to produce a completely converted starch, which shows no reaction for erythrodextrin and no cupric reducing power."—J. C. Small.—*J. Amer. Chem. Soc.*, 1919, *41*, 113.—*Journ. Soc. Chem. Ind.*, March 31, 1919, p. 193A. (A. W.)

Use of Filter-Paper Pulp in Analysis.—"By adding paper pulp to a solution containing a precipitate, the filtration of the mixture is often facilitated. The pulp is particularly useful in the case of barium sulphate, calcium oxalate, sulphur, and ferric and aluminium hydroxides. On the other hand, it should not be used when it is desired to separate a silica precipitate from a solution containing aluminium salts; the latter appear to have an astringent action on the fibres and the rate of filtration is retarded. The presence of the pulp in a mixed precipitate of aluminium and ferric hydroxides has the further advantage that, after ignition, the oxides are in a fine state of division and are readily soluble in hydrochloric acid. The pulp should not, however, be used when the hydroxides are to be re-dissolved in hydrochloric acid, since the latter attacks the fibres and much organic matter passes into solution."—O. Hackl.—*Chem. Zeit.*, 1919, *43*, 71.—*Journ. Soc. Chem. Ind.*, April 15, 1919, p. 225A. (J. A. W.)

Determination of Sulphites, etc.—"The principal results obtained may be summarised thus:—

1. The addition of a little glycerin to solutions of sulphites, or to caustic soda solutions used in absorbing sulphur dioxide, prevents any loss by spontaneous oxidation to sulphate. About 5% by volume of glycerin is a suitable quantity, and will usually be found ample. Passage of air and exposure to high temperature have no effect in the presence of glycerin.

2. The use of glycerin does not interfere with the accuracy of the estimation of the sulphite.

3. By titration with potassium iodate in solutions strongly acid with hydrogen chloride, sulphites can be estimated with a satisfactory degree of accuracy. The use of a stock solution of iodine monochloride, as recommended by Jamieson, is un-

convenient, on account of its instability, and is, moreover, unnecessary.

4. The absorption of sulphur dioxide from gases containing it, by means of caustic soda, is a very easy matter, perfect absorption being obtained with very simple apparatus.

In conclusion it may be pointed out that the method arrived at in this paper leads to very much higher results for sulphur dioxide in gases than are given by absorption in caustic soda to which no glycerin is added."—PERCY HALLER.—*Journ. Soc. Chem. Ind.*, March 15, 1919, p. 56T. (J. A. W.)

METALLURGY

CORROSION OF METALS.—"The authors have studied the action of distilled water and sea-water on copper and zinc in some detail, and conclude that the initial action is a process of chemical oxidation rather than electro-chemical displacement. Metallic zinc is normally covered with a partially protective scale, which consists largely of oxide or basic carbonate. Water containing carbon dioxide can attack or dissolve the oxidised layer, and zinc can then be found in solution as a slightly soluble bicarbonate. The attack on the scale begins at certain points, and a true metallic surface is exposed to the action of the water. At such places a peculiar form of oxide is formed on the surface of the metal. Probably this oxide contains zinc peroxide, and catalyses the corrosion of the underlying metal. It is slightly soluble and passes into solution, and is afterwards largely precipitated as the ordinary hydroxide and carbonate. The precipitated hydroxide has a distinctly protective action on the metal beneath it, and reinforces the original scale and enables it to resist the action of carbon dioxide. The action is thus localised. In the presence of very large amounts of carbon dioxide, as for instance, when the water is kept saturated by bubbling carbon dioxide through it, the products of corrosion are largely kept in solution and local action is almost entirely avoided, though the total amount of corrosion that takes place is increased. When metallic copper free from oxide is immersed in water a lower oxide Cu_4O or Cu_2O is immediately formed over the surface. This may become further oxidised at irregularly distributed spots, and the product thus formed does not protect the underlying metal from oxidation to the same extent as does the original tarnish layer. The dark oxidation product itself, which is probably a cupric hydroxide or basic carbonate, tends to flake off the metal, probably owing to the formation of bulky oxidation products beneath it. The latter are porous, and apparently amorphous, and probably act catalytically by increasing the rate of oxidation of the underlying metal. The amorphous oxide is slightly soluble, but it is finally precipitated from solution as crystalline cuprite, which has a lower solubility than the amorphous oxide. The result of the action ultimately is to cause shallow pits in the metal. Such pits are much less important than in the case of zinc. Experiments made to ascertain the effects of coupling together electrodes of different metals and immersing them in different electrolytes have led to the view that the effect of couples in some of the practical problems of corrosion has been over-emphasised. The local severe pitting at or near the water-line in the case of aluminium and certain light alloys when immersed in distilled water and sea-water is considered to be due to the presence of a strongly acid salt. The nature of the action of distilled water on 70 : 30 brass has been studied in detail by means of the microscope and by analytical methods. The action is considered to be the chemical oxidation of the copper and zinc, and the partial solution of the oxidised products. Most of the zinc passes into solution, in the presence of carbon dioxide, and part of the copper, the remainder of both metals remaining on the surface of the alloy as an oxide scale. The scale becomes further oxidised and altered at certain spots which become covered with thick deposits of the products of attack. Such deposits are porous and allow, and probably accelerate, local attack on the underlying metal. The attack is accompanied by re-deposition of copper by displacement of the zinc either electro-chemically or otherwise, and precipitation of cuprite. There are signs of slight local dezincification at such places, but the attack over the general surface of the alloy is complete corrosion. The positions at which local attack and pitting take place are not determined by the variation in the electrical properties of the original metal, but by the conditions of the experiment. In the presence of dilute acids, such as hydrochloric and sulphuric local action of the type described does not occur since there is little or no local accumulation of oxidation products. On the other hand, the absence of carbon dioxide retards the action. The action of sea-water is considered to be similar in type. Local pitting and dezincification are due to the accumulation of the products of corrosion. The rate of corrosion is much greater than that in distilled water, and does not fall off so rapidly with time. At the ordinary temperature there is less tendency to local dezincification. Different batches of condenser tubes of 70 : 30 brass have been found to possess surface layers differing in behaviour from the underlying metals towards corrosive agents. It may become possible to adapt the surface layer to the conditions under which the tubes will be used. Local action initiated in condenser tubes by such bodies as clinker and coke is associated with the accumulation of products of corrosion and may be largely assisted by them. It is usually characterised by intercrystalline oxidation. Acidified water (5 to 10 parts of acid in 100,000 of water) produces accelerated corrosion and alters the type of action. Admiralty condenser tubes (Cu 70, Zn 29, Sn 1) are decidedly more resistant than 70 : 30 brass to the action of dilute acids. As regards the practical problem of protecting condenser tubes from corrosion, the authors consider that no one single remedy is likely to be found effective for all the different kinds of attack which occur in practice. The nature of the tubes used and the protective measures chosen should be dependent on the particular set of conditions. A list is given of the characteristics which the cooling water should possess, and the chief causes of corrosion are tabulated with notes as to their action, together with suggested remedies. The effect of the presence of scale on the rate of corrosion is considered to be of great importance, and of substances commonly occurring in scale, calcium carbonate is one of the most important. This compound may exert almost any kind of effect,

Vol. X., p. 263.

according to its physical condition, from a considerable degree of protection to a serious attack. Observations of the working of the Cumberland process (J.S.C.I., 1916, 51) at a power station near Brighton have shown that, under the conditions prevailing, a prolonged life of the tubes is ensured, provided that the process is applied to new tubes. The authors consider that the thin uniform scale which is maintained on the tubes by the process, is an important factor in preventing serious corrosion. One of the important functions of the scale is to prevent contact between the tube and harmful deposits and products of corrosion; in addition, it retards, but does not entirely prevent, the general oxidation of the tube. Other possible methods of protection are briefly considered, and a preliminary account is given of a pre-oxidising process for reducing the rate of corrosion."—G. D. Bengough and O. F. Hudson. *Inst. of Metals*, Mar. 1919.—*Journ. Soc. Chem. Ind.*, April 30, 1919, p. 258A. (J. A. W.)

Volatilisation of Gold.—" Sir Thomas Kirke Rose, D.Sc., A.R.S.M., has placed before the Institution of Mining and Metallurgy the following conclusions, as the result of numerous experiments :—

1. True volatilisation of gold is so small as to be negligible at the temperatures of industrial melting furnaces, say, 1,000° to 1,300°. It is difficult to measure with accuracy the infinitesimal amounts volatilised at these temperatures.

2. Probably the nature of the atmosphere, provided that it is maintained unchanged, has no effect on volatilisation. Even in a strong draught, the amount volatilised remains exceedingly small.

3. Certain gold alloys when molten take up oxygen from atmospheres containing it and will afterwards spirt or effervesce in a reducing atmosphere until the oxygen has been removed. Similarly, hydrogen, and, in a less degree, carbon monoxide, is occluded by such molten alloys, and the metal then spirts in an oxidising atmosphere. In spirting, showers of globules of the alloys of all sizes are thrown up, and the smaller ones, especially those of less than 0·001 mm. in diameter, are carried away by any draught, however slight, and are difficult to recover. They can be collected by such a filter as cotton wool.

4. The action is observable in all the alloys of gold with silver or copper. Even parted gold containing one part per 1,000 of silver is affected, though to a far less degree than coinage alloys, gold, silver, parting alloys, and similar materials, Fine silver and its alloys with copper also spirt freely.

5. It is this action which causes the unrecovered losses in melting such alloys in crucibles, without a cover of slag."—*The Engineering Review*, 15th April, 1919, p. 289. (J. J. R. S.)

MISCELLANEOUS

Belt Dressing. " Leather belting can be made to transmit the maximum of power when careful attention is paid to its condition. The driving face of the belt should be kept in a clammy or mastic state by applying a good coating of reliable belt dressing at intervals of about eight weeks. The dressing should be made up of fish oils and animal fat to a consistency of soft ointment, spread over both sides of the belt with a square brush like a shoe brush. A belt attended to in this way will run much slacker than a dry belt will do, and the pulling side will hug and suck to the pulleys, while lifting the load without slip. There will be no loss of power from overloading bearings; a dressing of this sort keeps the leather fresh and prevents the atmosphere from penetrating into and drying the natural sap out of the leather while preserving its life for many years. Mineral or vegetable oils should never be used. Castor oil dressing soon causes leather to perish and rot. Boiled linseed oil makes a capital dressing for cotton belting; it soon oxidises and gives the cotton belt an elastic gummy driving face."—H. R. Kemp.—*Engineer's Year Book*, 1916, p. 653. (W. A. C.)

Industrial Explosives.—Development of Inertness—Investigations and Experiments.—Mr. E. A. Mann, F.I.C., Chief Government Inspector of Explosives in Western Australia, and Mr. T. N. Kerton, also an Inspector of Explosives, are the authors of a report on the above subject that is published by the Department of Mines, Western Australia.

It is stated that the concern of a Government Inspector of Explosives is to see that any explosive is reasonably safe to manufacture, transport and store, and that proper precautions are observed in such manufacture, carriage and storage. The inspectors' control ceases as soon as the explosive actually passes into consumption; he has nothing to do with its suitability for use.

It is true that at this point Government control is taken up and continued to some extent by Inspectors of Mines, but generally speaking their supervision applies rather to the conditions under which an explosive is to be used than to the quality or efficiency of the explosive itself.

One notable exception is to be found in the case of Permitted Explosives for Coal Mines, which have to pass very severe tests with regard to their practical effects before they can be used in colliery operations. Even here, however, the technical examination is applied at a preliminary stage, prior to the registration of the explosive; the practical authority of the inspector does not, as a rule, extend much beyond this stage.

The enquiries recorded in the report have been made with the object of ascertaining the nature and extent of the control that is possible, and some of the points regarding explosives that have come under the observation of the authors from time to time are recorded.

In describing the meaning of " Safety in Use " it is said that an explosive might be exuding or possess other physical characteristics (the result either of imperfect manufacture or of deterioration) which would render it unsafe to put in the hands of miners for use in boreholes. But this is not the only sense in which an explosive may be considered as unsafe for use. The explosive may be of such a character that, although in outward appearance it present nothing abnormal, yet when used for blasting it may be undesirable for one of the three following reasons :—

(1) It is inefficient, that is, it performs a poor proportion of work compared with the same quantity of explosive in first-rate order.

(2) It causes an undue proportion of noxious gases, especially those representing the products of incomplete, or slow combustion,

such as carbon monoxide and nitric oxides.

(3) Its explosion may be so incomplete as to leave unexploded portions, or "butts" in the bottom of the hole.

Insensitiveness.—The general conclusion arrived at is that explosives originally in first-class order, upon storage under conditions existing in Western Australia, undergo some progressive change, which gives rise to marked insensitiveness in the course of time. Although the actual causes of this insensitiveness are still obscure, there are certain data to indicate that it is due to some molecular change in the nitro-cotton constituents of the explosive.

The investigations have been applied only to explosives of the nitro-glycerine class commonly used upon the goldfields in the State, comprising blasting gelatine, gelatine dynamite, and gelignite.

In every text-book on explosives are to be found methods devised for determining the force developed by an explosive, but it is common to find a certain amount of looseness of language in reference to this subject. The terms "force" and "power" have frequently been used as if they were interchangeable terms, but this is not correct.

The true definition of power is contained in the equation $P = \frac{F}{T}$ where P equals the power, F the force or energy evolved, and T the time taken in its evolution.

Of two explosives capable of developing the same amount of energy, that which can develop the energy most rapidly is the one which will possess the most power.

Hence considerable study has been devoted to determining the velocity of detonation of explosives under different conditions and the enquiries recorded are based very largely upon the application of such methods.

The two principal means of experimentation that have been applied to the determination of velocity of detonation, viz., that known as Mettegang's Recorder and the D'Autriche method, are referred to. On account of its greater ease of application, the latter method has been adopted in the Western State, and the authors describe the method in detail.

The determinations of the velocity of detonation of explosion by the above method have been accompanied by other inquiries :—

(a) As far as possible exact information has been collected as to the actual behaviour of the explosive under working conditions, either by reports obtained from managers of mines or by tests conducted personally underground, and some very interesting and valuable data have thus been obtained.

(b) The oxygen balance of the explosives as determined by chemical analysis has always been kept in mind, and, so far as possible, the results of theoretical calculations have been confirmed by sampling and analysing the gases formed under working conditions.

In carrying out the underground tests an endeavour has been made to see what relationship, if any, exists between the working efficiency, the chemical composition, and the velocity of the explosive.

The influence of the physical condition of the explosive (such as the nature of the incorporation of its ingredients and its moisture content) has also been observed.

In this way explosives which have come under notice under a variety of conditions have been has been obtained, tending towards the formation of fairly definite conclusions bearing upon the practical control of explosives.

Such a large number of tests have now been carried out that it would be impossible to present them all ; but every instance has been amply confirmed. The extraordinary degree of insensitiveness to which some explosives can attain would appear to be almost incredible, and some of the instances quoted have never before been recorded, and they constitute records of great practical value.

One of the instances referred to is described as follows :—

In November, 1913, in consequence of a complaint as to the inertness of certain stocks of gelignite on the Murchison goldfields, samples were obtained and examined. This explosive, which had been manufactured in 1910-11, was tested by firing a column about 10in. long (4 plugs) by means of a No. 6 electric detonator.

The first two plugs exploded and the third was half-exploded and half-shattered, while the fourth remained unaffected.

Samples of explosive of the same manufacture remaining in the coastal magazine at Fremantle were taken and similarly tested, with the same result.

Samples from a shipment of gelignite made by the same firm, but recently arrived in the State, when similarly tested, exploded completely.

The density of the inert explosives was found to vary from 1.697 to 1.70, while that of the active gelignite was 1.61.

The inert explosives were further tested by confining ten plugs in a galvanised iron tube and firing as before. A portion only of the column of explosive detonated, as shown by the rending of a portion only of the tube, while the remainder ignited and burnt away.

Five instances of experience with inert explosives are given and the descriptions of the phenomena observed are amply illustrated with photographs.

Influence of Sodium Nitrate.—The regulations governing the authorisation of explosives in West Australia do not permit of the use of sodium nitrate as an ingredient of nitro-glycerine compounds imported into the State. Owing to the conditions arising out of the war, the embargo upon the use of sodium nitrate had to be suspended temporarily, and for some time past practically all the explosives imported there have been made with sodium nitrate replacing the ordinary saltpetre.

As regards the development of inertness, special attention has been given to these sodium nitrate mixtures to ascertain whether the alteration of ingredients had any effect with regard to this physical property. The general conclusion arrived at has been that sodium nitrate explosives are apt to develop inertness in a shorter time than those manufactured from potassium nitrate, but some difficulty has been experienced in getting sufficient instances of conclusive comparisons owing to the inability to obtain samples of potassium nitrate explosives.

An interesting series of tests was carried out on the mines at Kalgoorlie, in which an attempt was made to correlate the efficiency of the explosives with its chemical composition and its velocity of detonation. Eight different lots of explosives were tested, and tables give a summary of the data obtained.

Some interesting experiments are described that were carried out by Messrs. Nobel and Co. to test the accuracy of the open D'Autriche method as a means of judging the behaviour of an explosive in actual practice.

In referring to the practice that has become general on the mining fields of the State, to employ detonators of increased power to avoid unexploded remainders in bore holes, and whereas a few years ago a No. 6 detonator was considered sufficient for all purposes, No. 7 and No. 8 detonators are now generally used.

It is stated that it was therefore thought advisable to ascertain what effect would be exercised upon the D'Autriche test if, instead of the No. 6 detonator prescribed, No 7 or No. 8 detonators were employed both for the original impulse and also upon the extremities of the T.N.T. fuse.

It is interesting to note that, although a considerable number of comparative tests have been made, in no instance has it been found that the velocity of detonation has been modified by the use of the more powerful detonator and, accordingly, No. 6 detonators are now used throughout.

Causes of Inertness.—While the investigations which were begun in the laboratory some years ago with a view to throwing light on the cause of this inertness are amongst the investigations which have had to be suspended on account of the war, the results obtained up to a certain point were suggestive, and while there is a desire to hesitate before bringing forward definite conclusions based on these experiments, it is thought desirable to give expression to the impressions formed, in the hope that amongst the large amount of research work on explosives now being conducted in various parts of the world, other data may have been accumulated which would supplement these tests and render their interpretation conclusive.

In the first instances, a number of experiments were conducted on samples of nitro-cotton (as used in the manufacture of explosives) dissolved in amyl acetate. These solutions were subjected to the influence of raised temperature and the changes of viscosity in the solutions carefully determined. Marked changes were observed, and after twelve hours' incubation at 100 deg. C. it was found that the solution had attained nearly the same viscosity as the solvent. The indication of marked molecular change thus afforded was confirmed by similar subjection of dry nitro cotton to a temperature of 100 deg. C. for fifty hours, when it was found that the optical rotation and the refractive index had both been increased while the viscosity had decreased. The nitro-cotton recovered from the amyl acetate solution after incubation for twelve hours was rapidly and completely soluble in alcohol and formed a gel on spontaneous evaporation, but at the end of forty hours' incubation no such gel could be obtained. No change had taken place in the nitrogen content of the cotton.

In the second place, it was shown by experiment that the presence of nitro-glycerine in such a solution of nitro-cotton was without influence upon the viscosity change.

In the third place, gelignite, after incubation for 31 days at a temperature of 100 deg. F., gave indications of a similar molecular change. The explosive was extracted with ethyl acetate to dissolve nitro-cotton and nitro glycerine, and the viscosity of the solution was determined. It was shown by comparable tests before and after incubation that the viscosity was greatly reduced as the result of exposure to the above temperature, and as it had been already shown that the presence of nitro-glycerine in such a solution did not affect the viscosity, this change must be attributed to a molecular variation in the nitro-cotton.

In connection with this same branch of the enquiry, the velocity of detonation of the explosive was determined before and after incubation, and a typical case may be quoted in which it was shown that an explosive giving a velocity of detonation by the D'Autriche method of 2483 m/s before incubation, after 31 days' exposure to 100 deg. F., gave a velocity of detonation of 1600 m/s only.

It is difficult, therefore, to avoid the impression that the fall in velocity of detonation is connected with a molecular change in the cotton, and that this molecular change can be produced by temperatures as low as 100 deg. F.

Temperatures of this range are, of course, a very common occurrence in the climate in some parts of Australia, and even in magazines specially constructed to provide against extreme fluctuations of temperature it is not uncommon to obtain records of over 90 deg. F. The complex molecule which exists in nitro-cotton has been made the subject of much study, but is still a matter surrounded by obscurity; but it is suggested by the experiments conducted in this Department that the development of inertness in explosives is probably due to a splitting-up of the more complex into simpler molecules in the nitro-cotton constituent of the explosive under the influence of raised temperatures, the rapidity and completeness of the change being governed by the height of the temperature and the period of its duration.—E. A. MANN and T. N. KERTON. -*Industrial Australian*, January 30, 1919, p. 199. (C.J.G.)

Abstract of Patent Applications.

744.19. H C Jenkins. Improvements in electrolytic cells. 11.9.19.

This application relates to improvements in electrolytic cells for carrying out oxidation or reduction processes of the type which have electrodes, of which one is contained in a porous covering (such as a bag) or a perforated surround (such as a box). The application has mainly for its object to promote uniform circulation of the electrolyte in the region of the exposed electrode, but to hinder circulation in the region of the protected electrode.

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Proceedings
AT
Ordinary General Meeting, March 20, 1920.

The Ordinary General Meeting of the Society was held in the South African School of Mines and Technology Building, Johannesburg, on Saturday, 20th March, 1920, Mr. James Gray (President) in the chair. There were also present:—

20 Members: Messrs. G. A. Watermeyer, H. R. Adam, C. J. Gray, J. J. R. Smythe, J. R. Thurlow, F. W. Watson, H. A. White, Dr. W. A. Caldecott, W. R. Dowling (Members of Council), A. Baguley, R. Dures, W. S. Gordon, L. D. Hingle, J. H. Johnson, J. M. Neill, C. B. Simpson, A. Thomas, J. Thorlund, John Watson, and J. A. Woodburn.

2 Associates: Messrs. J. A. Boyd and A. A. Wood.

3 Visitors, and H. A. G. Jeffreys (Secretary).

MINUTES.

The Minutes of the Ordinary General Meeting, held on 21st February, 1920, as recorded in the February *Journal*, were confirmed.

NEW MEMBERS.

Messrs. J. Watson and C. J. Gray having been elected as scrutineers in connection with the election of new Members, the following were declared unanimously elected:

BOURKE, EDMUND FRANCIS, Bourke Trust and Estate Co., Ltd., P.O. Box 831, Pretoria. Director of Companies.

CLAYDEN, HAROLD WILLIAM, General Mining and Finance Corporation, Ltd., P.O Box 1242, Johannesburg. Consulting Mechanical and Electrical Engineer.

CLIFFORD, EDWARD HUBERT, Central Mining and Investment Corporation, Ltd., P.O. Box 1169, Johannesburg. Mining Engineer.

JARDINE, IVOR KENNETH, 52 Standard Bank Chambers, Commissioner Street, Johannesburg. Mechanical Engineer.

LEISK, JAMES RANKINE, Central Mining and Investment Corporation Ltd., P.O. Box 149, Johannesburg. Director of Companies.

ROBERTSON, LEONARD ARGYLE, New Goch G.M. Co., Ltd., P.O. Box 1096, Johannesburg. Surveyor.

WOODBURN, JAMES ALLAN, P.O. Box 396, Johannesburg. Mining Engineer. (Transfer from Associate roll.)

GENERAL BUSINESS.

APPOINTMENT OF SECRETARY.

The President: The Council has appointed Capt. H. A. G. Jeffreys, O.B.E., as Secretary to the Society, and we hope his association with the Society will be as long and as pleasant as that of his predecessor.

MR. F. ROWLAND.

It has been decided to record our appreciation of the services which Mr. Rowland has rendered to the Society by means of a presentation. An appeal in this connection will be issued at a very early date. I have no doubt that members will be only too pleased to take advantage of the opportunity which will be afforded.

ANNUAL DINNER.

The Annual Dinner has been arranged for the 8th May at the Carlton Hotel; tickets, price 25/-, exclusive of wines.

JOINT HOUSING.

The first stage of the scheme for the closer union and joint housing of Technical Societies has, as will have been observed in the Press, come to a successful termination, thanks to the generous manner in which the Chamber of Mines has supported the Technical Societies.

The building which formerly housed the Johannesburg Club has been purchased for a sum of £22,500 by the Associated Scientific and Technical Societies of South

Africa, and, in this connection, the Chamber of Mines has lent to this body a sum of £10,000 at 5% on second mortgage. They have also agreed to pay the interest on this loan, and also on the first mortgage of £12,500 for two years, and have undertaken to subscribe 10/- for every £1 raised by the Technical Societies, up to a total amount of £5,000.

I am sure you will all agree that we are greatly indebted to the Chamber of Mines for this most generous financial assistance. We ought also to record our appreciation of the work of our representatives, Professor Wilkinson and Mr. Meyer, on the Joint Committee, as well as to the other gentlemen who have represented their Societies on this Committee, and I would especially mention Mr. Percy Cazalet, whose enthusiasm has undoubtedly resulted in carrying this scheme for joint housing to a satisfactory and successful termination.

OBITUARY.

I regret to announce that Mr. H. Jennings, who was an Honorary Vice-President of the Society from 1898 to 1910, recently died in America. I would ask you as a mark of respect to rise. All members rose.

WHITE LABOUR AT THE CONSOLIDATED LANGLAAGTE MINE.

The Secretary has a note from Mr. A. E. Payne on the working of the Consolidated Langlaagte Mine by white labour during the recent native strike.

Mr. A. E. Payne *(Member)*: Arising out of the strike of natives at the Consolidated Langlaagte Mines in February last, the white underground employees approached me with a request that they might be allowed to go underground and work, provided that I would arrange to get the mill and reduction works in running order. It was felt that the enforced idleness of the white men was creating an undesirable impression in the minds of the native strikers that they, the natives, were indispensable. In some cases certain natives were stated to have had wordy passages with their former white overseers, which might have led to blows.

Consequently, I agreed to the experiment on the understanding that the work should be undertaken in a loyal spirit, and not with the idea of just putting in time to claim wages.

Work was concentrated in one section of the mine, and was confined to tramming and shovelling the broken ore already lying in the stopes.

It is a pleasure to record that the men responded with an excellent spirit, and amusing incidents occurred in which men refused to stop and talk with officials lest their mates should think they were slacking on the job.

Work commenced on February 23rd, and was carried on for two days only. During this time 203 white shifts were returned, and a truck tally of 609 was given in by the mine overseer. The truck in use was a low type, 20 cubic feet Hudson car, with fixed frame and one can assume that the duty per white man per shift was aproximately 3 tons.

PRICE OF GOLD.

Mr. H. A. White *(Member of Council)*: I would like to call the attention of members to the excellent diagram by Dr. Caldecott, published in the February *Journal*, connecting the premium on the gold with various working costs and the yield in pennyweights per ton of ore milled required to pay. I have suggested to Dr. Caldecott that the formula on the last line might be more simply put in the form of:—

Working cost per ton in shillings. price per ounce of fine gold in pounds the payable limit in pennyweights of fine gold per ton of ore milled.

SOME SUGGESTIONS ON IRRIGATION.

By A. Baguley, B.Sc., F.I.C. *(Member)*.

To a society of catholic sympathies like this, with its frequently expressed concern for communal well-being, I make no apology for introducing a subject of such fundamental importance as irrigation. One of our vice-presidents has well said, that water is the principal fertilizer, a truth that none of us, after the experiences of recent years, will gainsay.

To make an unqualified success of any scheme of irrigation, the engineer, the chemist and the agriculturist, ought all to be consulted; the last by no means least, as having to operate the finished work.

If by a restatement of some of the elementary principles of crop-raising, and a few suggestions on theoretical questions, and the overcoming of practical difficulties, a discussion is provoked, which results in an actual trial on a commercial scale, our time will have been well spent.

Water has to serve several important purposes in the soil and for crop-growth. Its amount and quality determine its usefulness. It may be looked upon as the blood of the earth. Circulation is required and must be secured in some way. In many places, the natural drainage is good, owing to the slope of the land, its position, or the character of the subsoil. In other places water has to be made to circulate by means of drains. These are necessary in heavy soils with compacted subsoils, in low-lying vleis, and in enclosed valleys and pans.

(1). Like blood, the water of the soil has to carry oxygen. This is necessary for the health of the soil as a medium for crop-growth. Without air, the decay of organic matter becomes reduced in amount and is made dangerous in character, by reason of toxic organic bodies, which are freely produced. Mineral substances, harmless enough when fully oxidised become poisonous when reduced. An application of water to the soil results in the displacement of the vitiated air already in the soil and its replacement by fresh air from the atmosphere above. The soil gets a much needed health-giving breath. The rate of oxidation is increased for a time by reason of the greater concentration of oxygen within the soil. Russell at Wye has shown conclusively that the productivity of a soil is proportional to the rate at which oxygen is absorbed by the soil. *(Journ. Agri. Sci.*, Vol. 1, p. 261.)

(2). The water of the soil is the solvent and conveyor of food-material. It is the medium by which the plant-food is elaborated, and the vehicle by which it is transferred.

(3). The water of the soil has to be changed because it serves the purpose of a scavenger and removes deleterious matters which would otherwise accumulate with increasing rapidity and become dangerous.

(4). Water has also to lave or bathe the soil, and maintain some uniformity in temperature. This function it serves excellently by reason of its high specific heat and high latent heat of evaporation. Without a supply of water the surface of unshaded soil often becomes dangerously hot.

(5). Water is required to keep plant cells turgid, and to maintain the whole frame-work erect and rigid. This is the condition essential to development and increase.

(6). Just as the carbon of the plant is supplied by the breaking up of the carbon dioxide of the air, so the no less important hydrogen is provided by the decomposition of the water derived from the soil.

Now to serve all these purposes efficiently, it is clear that to grow a crop a large amount of water is necessary. To supply the six per cent. of hydrogen in two tons of dry plant substance, about 2,300 lbs. of water must be decomposed. This is the least demand.

For transpiration an amount of water varying from nearly three hundred to over eight hundred times the dry matter produced is required. If the dry matter of a crop is two tons per acre, this would represent all the water in a rainfall of from six to sixteen inches. This amount of water must actually enter the plant and pass through it.

Water is also required to provide the supply necessary for evaporation. Ordinary evaporation from a water surface in this country will result in the volatilization of something like six thousand tons of water per acre per annum. That amount is probably scarcely ever available in agriculture. Crops are often wilted and injured by the high temperatures developed in the surface of poorly shaded dry soils in consequence of the want of water for evaporation.

In addition to the great demand for this purpose, there is the need to provide for occasional drainage. Only in very exceptional circumstances is it possible to get the best results without drainage, and irrigated lands unless naturally well drained ought always to be provided with means of discharge.

In view of the varied usefulness of water, in the development of the crop-plant, it is evident that the rainfall, conserved to the utmost extent, is not generally over-plentiful. Too frequently it flows off down the slopes without entering the soil, and if the drenching showers we sometimes get could be induced to pass through the soil instead of flowing over it into the nearest sluit, the ground would receive many a grateful moistening it now misses.

Rain-water is usually much better than stored water, whether got from a dam, well or borehole.

(1). It is more highly charged with oxygen due to its intimate association with air.

(2). It is free from dissolved impurities that are often harmful.

(3). Stored waters are sometimes cold and chill the ground to an injurious extent.

Where so much water is required for these various purposes, it is paradoxical to say that the provision of drainage is a most important factor in productivity. But that is the simple truth. It is a well-known fact that more water enters a drained soil than an undrained soil. This is so, for the reason that drains provide a way out for the air or water filling the interstitial soil spaces. In undrained soil these spaces are charged with air or water which is more or less stagnant, devoid of oxygen, charged with poisonous impurities, and neither of them therefore, capable any longer, of fully serving their useful purposes. In the absence of an outlet this stagnant water or air maintains its position and prevents the entry of other water or fresh air.

Circulation of water and air is greatly reduced with corresponding effects on the productivity of the soil. Rain water and irrigating water largely pass off over the surface while this air-lock or water-lock within the soil is maintained.

There is surely no need to labour the manifold and obvious advantages of draining even in a dry climate like ours. The main disadvantage is the expense. A drainage scheme may be begun at the bottom of the land where a suitable outflow for water may be secured, and gradually extended from year to year as its benefits are felt. Drainage may be effected by means of trenches, which, in favourable conditions of slope, need not be more than from two to three feet deep, and filled as to the bottom, with brushwood or stones, or cheap, porous earthenware pipes, made for the purpose. The trenches should be filled in, so as not to interfere with surface operations.

Everybody is familiar with the fact that after several waterings, the surface of cultivated ground becomes continuous, and loses its tilth and no longer permits of the free access of water. This destruction of tilth, due to watering, is a surface phenomenon, and the causes must be looked for among those influences which are operative at the surface, and not in the mass of the soil. The hardening of the surface is not entirely relieved by draining. In agricultural practice it is overcome by tillage operations, harrowing and scarifying; in horticulture, the upper layers of the seed beds are enriched with sifted dung, which will not cake, and which provides a surface capable of absorbing all the water that is required. Sometimes the seed beds are sunk below the surrounding level so that the water applied cannot escape. The hardening of the surface does not occur in pastures, or in lands that are well shaded by crops or mulched with manure. It occurs to the greatest extent in heavy soils, deficient in organic matter, exposed to the sun and air. Rain water or irrigation water alike produce the effect, though in some cases the latter appears worse.

Living agents, plant or animal, are all active in maintaining an open surface. Perennial grasses, shady crops, leaf mould, ants, worms, and other creatures, including probably, miscroscopic forms, are all useful in keeping an absorbent upper layer.

The caked surface is the result of exposure to drying winds. The soil is first of all cultivated, and the surface is left broken and absorbent. Rain comes or water is applied. The surface is saturated, and all soils are deflocculated and run together, except coarse sands and those with a large proportion of organic matter. The water sinks into the earth and dissolves such water-soluble salts as it there finds, particularly salts of sodium and potassium. Wind and sun then cause extensive evaporation at the surface, and the aqueous soil solution passes upwards to the surface, where its salts become concentrated and produce the impervious crust which is so unhealthy.

Carbon dioxide is freely formed in the soil, and sodium carbonate or bicarbonate is among the salts so represented. These salts are very powerfully destructive of tilth, and themselves would bring about the formation of a crust. It may be that sometimes the condition is partly due to the deposition of calcium, magnesium, or ferrous iron carbonates left in the surface by reason of the volatilization of the carbon dioxide which made them soluble. Where evaporation is prevented in any way, as by tillage operations or a shading crop, no crust is formed.

Horticulturists and florists will sometimes confess to applying water underground. They insert a pipe, end on into the ground, and by its means introduce water into the soil from below. This practice has several advantages.

1. The mulch of tilled earth is not detroyed by wetting the surface, and labour is saved.
2. Evaporation is reduced and water economised.
3. The surface soil does not become unhealthy to tender seedlings by the accumulation of water-soluble salts.

These advantages would be operative in the case of water used on a wider scale in agriculture. Irrigation water could be run into the ground through stone-lined ways, with open sides surrounded with gravel and covered with two feet of soil. The soil could be flooded with water through such a system of waterways. A similar system not connected, could be used to withdraw the surplus water at the bottom of the slope.

One advantage of applying water underground is that the method is adapted to sloping ground. There is not the same need to level the ground or work it in flats. The surface is not cut up by dams or channels which is a very great consideration in tillage and harvest operations. The land can be flooded in a short time. The contained air is driven out from below. Water passes through the ground in a horizontal direction, and finds its way out by the drains. Fresh air from the surface follows it, and when the drains cease running, the process can be repeated at any desirable or possible interval.

The quality of water for irrigation depends, first, on the amount of dissolved salts in the water, and, second, on their kind. Natural waters vary enormously in these respects, dissolved solids ranging from below twenty parts to upwards of two hundred, per 100,000 parts of water. As to whether a water is safe to use for irrigation, the main consideration is not the amount of dissolved solid, but its nature, and what becomes of it. If, as a result of irrigation, these salts accumulate in the soil and remain soluble, then they are highly dangerous, and the land will become increasingly infertile in spite of cultivation, fertilizers, water and all care. The remedies for this condition, and there is reason to fear it is widespread, are—first, drainage, or, if that process is too costly or impracticable, then, second, the growth for a time, of bulky crops which do not require irrigation. Such crops remove in their substance a proportion of the dangerous salt, and the soil recovers tone and health. The want of health due to this cause is seen most frequently on low-lying tenacious vlei soils, which are more or less level, and therefore adapted for irrigation by traditional methods. It is often difficult to arrange for a suitable outflow for the water from such places, and the want of outflow may prove disastrous.

The amount of water-soluble salts reckoned as a percentage of the soil is usually very low, but its proportion to the available water in a dry time may become very high, and then it is that extensive plasmolysis occurs and corresponding reduction of crop. In seasons and times of low rainfall the accumulation of salts produces its worst effects. When the soil is reasonably wet or overwet the salts produce no bad effect, and may even be reduced in amount. It is commonly said that poor soils produce their best in a wet season. Probably this is largely due to the elimination of the effect of the water-soluble salts, which, in a dry season may cause even a good soil to produce poorly. Soil and fertilizers are often blamed for a purely physical fault of this kind, not connected with either.

Two kinds of salts are notably bad.

1. The carbonates and bicarbonates of the alkalies. These are all extensively soluble in water, and their solutions dissolve organic matter and destroy tilth, making the cultivation of the soil very difficult.

2. All chlorides. These are all water-soluble, and by double decomposition with lime, usually the most plentiful base in the soil, lead to the formation of calcium chloride, a very highly deliquescent salt, that imparts an appearance of wetness to a soil which is harmful and deceptive, and also militates seriously against the production of a tilth.

Hard water, stored water, and water from the municipal supplies is frequently used by people to water gardens and plants, and keep them alive till the rains come. A common cause of surprise and remark is that such gardens and plants do not grow away as they should. All that the water seems capable of is to maintain life. The reason is to be found chiefly in the water-soluble salts present in the water. It would be an improvement on the usual practice to apply the water more freely at longer intervals, and at least secure some drainage at each application.

This familiar phenomenon is a small-scale illustration, rapidly brought about, of what is taking place slowly, unobserved over wide areas of our country, and it is just another reason for the development of drainage systems in irrigated areas.

Sometimes cultivated lands overlie subsoils charged with "brak" salts. On such lands irrigation has to be conducted with great care and skill in order to avoid a harmful efflorescence of "brak" at the surface. In such a case again a drainage scheme is every way the best safety valve that can be provided.

The disposal of the liquid excrement on farms where big stocks are kept is a matter scarcely ever thought of. Yet it has more than a little to do with many a farmer's problems.

Agriculturists are quite rightly, though not always very intelligently, urged to make use of all the waste excrementitious matter produced on the farm. Owing to the warmth of our climate and the rapid evaporation of water, the easiest method, and the one most commonly practised, of disposing of liquid excrement, is to dry it up on the solid and cart both out on the land. A little consideration will show how injudicious this proceeding is. It is true that the liquid contains notable amounts of readily available nitrogen. The advantages gained from this, however, are very much more than neutralised by the disadvantages attending the application of the large quantities of common salt which the liquid contributes.

Salt is essential to the well-being of herbivorous animals, and is being freely used by all enlightened farmers, either by itself, or as a principal ingredient in some one or other of the many varieties of cattle lick. From ten to twenty times as much salt is purchased as is sent off the farm in produce. The residue, amounting probably to some tons per annum, is added to the manure heap and conveyed to the soil. There, in a climate such as we have, the tendency is for it to accumulate, and it has bad effects on the productivity of the soil.

These effects are not at first very marked, but they become worse and worse, and in spite of all that can be done by cultivation and fertilizers, diminished crops are produced year by year in all but wet seasons.

The thing to do in a case of this kind is to dispose of the liquid, as far as possible, by itself, on a small area of ground conveniently situated, and grow thereon salt-loving crops as salt bush or mangels. The cattle could pass to and from their pastures through a plantation of salt bush, nourished in this way, with the liquor from the stables run into the ground through buried waterways. It is to be remarked that not all of the salt could be collected in this manner, but enough of it may be secured to make all the difference between success and failure in some cases, and to ensure great advantage in all cases.

The President: At a time when irrigation schemes and proposals are prominent within the Union, a contribution from the point of view of the agriculturist is opportune, and I am satisfied that Mr. Baguley's paper will promote considerable discussion. Mr. Baguley has emphasised the necessity in irrigation schemes of consulting the engineer, the chemist, and the agriculturist; but I am afraid that in connection with some of the schemes within the Union the agriculturist has not been consulted to the extent he should have been. I fear that the engineer—as he has done in the past—has ousted the agriculturist, and claims have been made for him which he would be the first to refute. The agriculturist deals with the principles which govern the application of water, *i.e.*, the method, the times and quantities, and the knowledge of the local conditions.

The author has emphasised the importance of drainage for preventing the sterility of soils, and instances of the neglect of this important question are already to be seen in connection with irrigation schemes in South Africa.

I would ask you to accord a very hearty vote of thanks to Mr. Baguley for his paper.

Mr. H. A. White *(Member of Council):* I would like to seize this opportunity of getting an explanation, from someone who is familiar with the subject, of the term "tilth." I have seen it frequently in agricultural journals. It does not convey much to my mind.

Mr. A. Baguley *(Member):* Tilth is a word which is in very common use among agriculturists, a word which they understand the significance of, but which I suppose is really a technical term. It refers to the state of sub-division of the soil, and it means the condition of soil in which there are many complexes of the finer particles. The soil as a whole is mealy and loose, but the particles are complexes of grains of sand and particles of clay; they are aggregates of soil particles. The soil in good "tilth," or the mealy condition, is distinct from soil in bad "tilth," which is a uniform mass.

Mr. John Watson *(Member)*: I have much pleasure in supporting the vote of thanks to Mr. Baguley for his interesting paper on "Irrigation." As you know, I was recently in India for a little over a year. On arrival there, I think the first thing that strikes one, as soon as you get away in the train and see India, is the thought that this is a country where they irrigate. In India they are behind the times in many ways. Going from Johannesburg to Calcutta is like going back to live in the early chapters of Genesis; but, in the matter of irrigation, I think we can learn a good deal from India.

In the early days in South Africa it seems a good deal of time was wasted over Roman-Dutch law and squabbling about water rights, servitudes, and so on. I believe, as soon as you go farming in South Africa, or try to buy a farm, you often find you cannot buy it outright, because someone has got a servitude, or road, or water rights. At any rate, in 1912 the Union *Irrigation and Conservation of Waters Act* was passed; and the official Year Book of the Union of South Africa for 1910-1916, published in 1918 gives the subject matter of the Act. The total amount spent on irrigation by the Government,—expenditure from loan funds and from revenue,—from 1911 to 1917 totals 2¼ millions, roughly. The Cape Colony is the Province where they have gone in chiefly for irrigation. I think we have to thank Sir Thomas Smartt very largely for a good deal that has been done in the Cape in the way of irrigation. I notice that the cost of irrigation works in connection with Olifants River, Van Ryns-dorp, and Clan William, was £252,500; that is one of the big ones. There is another, Calitzdorp, Oudtshoorn, where £120,000 was spent on irrigation works.

There is an old saying that "it never rains but it pours," and we know how it rains in this country. I remember being on the old Stanhope Mine, just before the South African War, and we were shut down for want of water. One night we got 4·7 inches, and were nearly flooded out. The next day we started up and had enough water to go on with. In India, last August, between midnight and 3 a.m. one morning they had 7·29 inches of rain. A few months ago this country (South Africa) suffered from drought. We had 0·66 of an inch one evening, and the *Rand Daily Mail* said it was no good, and that what we wanted was a soaking rain lasting for three days. If the farmers of this country could catch that excess water, to be used as required, and get the Government to help them, they should obtain a payable return on their money as they do in India, and this should be a good thing.

The following paragraphs from the Indian Year Book for 1919 are of interest:—'In the West irrigation is a rarer luxury designed, where it exists, to increase the productivity of a soil sure of a certain crop under a copious and well-distributed rainfall. In great parts of the East, and especially in India, it is a necessity for existence. For, in India, there are large tracts, such as the deserts of Sind and the South-West Punjab, which are practically rainless; there are others, such as the Deccan Plateau, where cultivation is exceedingly precarious, owing to the irregularity of the rainfall and the long intervals when the crops may be exposed to a blazing sun and a desiccating wind; there are some crops, like rice and sugar-cane, which, except in a few highly favoured districts, can only be matured by the aid of irrigation. There are great areas where a single crop, which is called the *kharif*, or rain crop, can in normal years be raised by the unassisted rainfall, but where the second crop, the *rabi*, or cold weather crop, is largely dependent on irrigation. Inasmuch as in India 65% of the population is still dependent upon agriculture for the means of livelihood, this brief summary indicates the enormous importance of irrigation to the community.'

In the direction of constructing large works, for utilising the surplus waters of the great rivers, little was done before the advent of British rule. The State has intervened, and irrigation works in India may be divided into three main heads—wells, "tanks" (what we should call dams, or reservoirs), and canals. The last-named are the greatest, and constitute one of the most enduring monuments to British rule. During the vice-royalty of Lord Lawrence, it was decided that all irrigation works which provided a reasonable return should be constructed by the State from loan funds as productive public works.

The Irrigation Commission was appointed by Lord Curzon's Government in 1901, in order to substitute policy for spasmodic effort. It made a survey of the conditions of the country, and produced the report which is the foundation of Indian irrigation policy to-day. In a table given in the Indian Year Book it is stated that the total capital cost of Government irrigation works up to the middle of 1917 was £71,240,000 sterling, compared with which our younger country, the Union of South Africa, has spent a total, up to 1917, of £2,257,000 sterling. The estimated value of crops raised on the above areas (receiving State irrigation) in a single year in India was £91,980,000 sterling, or, roughly, double the value of the present average gold output of the Transvaal.

C. J. Gray *(Member of Council):* I should like to ask Mr. Baguley whether the method of applying water underground through pipes or underground channels has been carried out on any large scale. Does the application of water in that way have any detrimental effect, by unduly cooling the soil or carrying "brak" to the surface, or is it the case that the system of drains provided in addition to the water channels clears away "brak" satisfactorily? If the method is successful with regard to "brak," it has the advantage of permitting cultivation of the surface to be kept up without hindrance. It enables us to get the advantage of the dry land system of cultivation as well as of irrigation.

Dr. W. A. Caldecott *(Past President):* Mr. Chairman, with reference to this instructive power of Mr. Baguley's, I should first like to comment on the remark that you have made with reference to the co-operation of the engineer and the chemist. I think if you refer to an annual report by Mr. Kanthack (Union Director of Irrigation) during the last year or two, you will find that he expresses full appreciation of the need of chemical knowledge and likewise of geological knowledge by the engineer in considering the development of any irrigation scheme.

In regard to the author's points, I should like to ask him whether, in reference to oxygen, he considers its beneficial effect as being solely due to its oxidising ferrous compounds, or whether he does not consider it also important in supplying oxygen to the nitrifying bacteria which form nitrates. It seems probable that the fixation of nitrogen through the presence of oxygen may have as important an influence on the productivity of the soil as the oxidation of any ferrous compounds present.

The author mentions irrigation water as being of two kinds—rain water, or water from tanks or boreholes. I might point out that in South Africa irrigation is very largely done by means of turbid flood water, to which Mr. Baguley does not refer, and which contains suspended silt solids. I think Dr. Juritz has pointed out with regard to samples of water from the Orange River when in flood, that the amount of suspended solids present saved several pounds' worth of fertilizing constituents (nitrogen, potash, phosphoric oxide) per acre. In Egypt, they have been irrigating for some 4,000 years without fertilizers, which is due to the fact that as much plant food is carried in the silt as is removed by the crops.

The author has laid great stress on the matter of drainage. We know that in humid countries it is a very necessary thing and common practice, but in this country there is usually so much suitable land in proportion to the volume of water available that I am inclined to think it is usually possible and desirable for a farmer to choose for irrigation such areas as are naturally well under-drained rather than those which are liable to become water-logged or "brak."

CAN AMALGAMATION BE DISPENSED WITH?

E. M. Weston (Member of Council)

Printed in Journal, February, 1920.

DISCUSSION.

Mr. J. M. Neill *(Member):* The only reply to the question is,—Yes! But to bring about discussion, I will suppose we are asked—"Can amalgamation as practised on the Rand be profitably dispensed with?" The reply to this is, No! The proposals under discussion would not affect this negative, as they are too vague, not supported by figures, nor as the facts and theories used, properly interpreted.

To stimulate the author's power of thought and encourage him to alter one of his conclusions, I will quote from his paper the following:—

Thompson says:—"In order that amalgamation or union between gold or silver and mercury can take place, they must be brought into intimate contact." Henry

Louis:—' This operation proceeds by surface contact, and therefore requires time for its completion." Teesdale:—" Despite the fact that his plates caught gold all the way down, amalgam accumulated between the riffles of the Wiltley's situated below them." Author's remark:—" The flow of pulp may be too rapid; the finer particles of gold if free may be carried off."

Should the foregoing not completely justify the Van Ryn Deep Consulting Engineer increasing his plate area, anything further is supplied when the author says " the grade of the ore had increased, and the tonnage milled had slightly increased." May I add that, from an amalgamator's point of view, the plate area never had been sufficient

The author quotes Read, and he himself enlarges upon the surface tension of mercury in relationship to amalgamation. In both cases he supports a certain depth of mercury film, his words being, " Surface tension of mercury, etc., draw down particles disturbing the *level* surface, etc.' Level surface I take to imply a certain depth of mercury. In another place the author expresses certain doubts regarding " a deeper film doing better work." Why he goes into this speculation in connection with his proposals I quite fail to see. To ascribe influences in this matter of surface tension to change of temperature alone, when an amalgamable pulp is passing over a copper plate, is to ignore mass, pulp density, chemical constitution, and an infinite variety of factors.

The author should ponder an extract in the December number of the *Journal*, entitled, " Technical Writing: Naturalness." As far as I am concerned, I am quite content to accept Thompson quoted above.

However, as the author seems to desire information *re* film depth and surface tension of mercury, I will record my own observations, with this reservation; the use of the word clean, is to be interpreted as meaning, clean under the circumstances. The operations were performed in the ordinary atmosphere of a working stamp mill.

It will be observed that, so far, the influence of gold or copper has not been dealt with. If the mercury does all the work why were troughs of mercury and immersion contact abandoned? To proceed, take a drop of freshly retorted mercury, place it on a clean scoured copper plate. It stands up as a round bead with flattened base. Some force is necessary to overcome the surface tension exhibited by the mercury, and so get it to amalgamate with the copper. When this has been managed, place another drop of clean mercury on the plate already amalgamated. There is a marked change, the bead is no longer round topped, it is almost flat. Now add to the mercury different kinds of contaminants, and mark the different results. Clay, grease, or organic matter of some kinds, do not seem to affect the surface tension materially, the little balls are as round as can be. Some acids, cyanide solution, and sodium have marked effects. Metallic sodium, if plunged below the mercury surface, gives the most surprising result. A drop of mercury so treated flattens out entirely and immediately on the prepared plate.

It would seem, therefore, that the copper-mercury coated plate exercises forces complementary to and greater than, the surface tension of mercury alone, and that the thinner the film of mercury the better it is for amalgamation. So also with gold-copper-mercury. The forces exercised by this amalgam would be expected to be greater than those of mercury-copper alone, and give the reason for a gold-coated plate giving the best recovery results. Here also is the reason for the claim that sodium amalgam is beneficial. When sodium is used it is imperative that the pulp is kept constantly alkaline.

A few figures will be interesting. From the time the Rose Deep mill started working till 1903, the north side invariably returned more amalgam than the south side. There was no apparent reason.

In July, 1903, all factors remaining the same, (except that I had been appointed south side foreman), I started cleaning the mercury with sodium. Results taken from mill log books showed a difference in favour of south side as follows:—

	Oz.		Oz.		Oz.		
July	257	Dec.	357	May	329		
Aug.	460	Jany.	483	June	723	—1 year	5587
Sept.	401	Feby.	559	July	570		
Oct.	412	Mar.	684	Aug.	255		
Nov.	764	April	158	Sept.	301—		1126
	2294		2241		2178	=	6713 oz

I do not claim that the former minus, altered to 6,713 troy oz. of amalgam, plus. in 15 months, is entirely due to the use of sodium, but a great deal of it is.

There may have been some personal element inducing a spirit of healthy rivalry and contentment, which would account for some gain. The Reduction Officer noticed the change, and retorted separately on several occasions, with the result that the south side had the highest percentage of sponge to amalgam.

Turning again to the author's statements and figures, why does he challenge 95% of amalgamation recovery on first 3 feet of plate. On oxidised ores that was often demonstrated. I have seen more than 95% of the total amalgam recovered similarly on less than 3 feet before the introduction of cyanide. Day is quoted as recovering by means of shaking table "300 oz. of lumps of amalgam escaping from plates per month." "There were mercury losses of 0·07 oz. per ton crushed, or 3 oz. per oz. of gold recovered; and later again reduced to 0·17." To reduce 0·07 to 0·17 is curious. $\frac{3}{0{\cdot}07} = 42{\cdot}85$ = No. of tons crushed to produce 1 oz. of gold won = 0·467 dwt. per ton. To use plates to recover this is absurd, but to recover 300 oz. of escaping lumps of amalgam from this, makes one think there is something wrong somewhere. Further on, the decimal points referring to the diameter of particles in the tube mill pulp are in the wrong places. They should read:—

+60 +90 +200
0·01″ 0·006″ 0·003″.

This is important, as particles of 0·006″ diameter and less come within the range of "Law of Viscous Resistance." It is proved by Richards and Stadler that particles of—

0·002″, say, 0·063 mm., fall with velocity of 2·52 mm. p. sec. = about 6″ p. min.

0·006″, say, 0·158 mm., fall with velocity of 16·0 mm. p. sec. = about 37½″ p. min.

Why particles falling with those velocities should not compete with gold, which, according to the author, when shaken up with water took several minutes to settle, I cannot quite grasp!

Nor can I agree when the author says the New Goch method "involves a lot of unnecessary labour." To me it seems excellent, but open to improvement along deflotation lines indicated in our *Journal*.[1] In those articles the recovery of 66% shown in the mill up to the time deflotation was adopted, was by means of amalgamation and canvas strakes. The increase to 72% was obtained by amalgamation of defloted particles, which formerly had escaped both plates and canvas strakes. Some of those particles probably increase the cyanide residue,[2] and therefore I maintain that amalgamation here cannot profitably be dispensed with. Having shown previously the adverse influence of air in connection with the author's somewhat indefinite proposal, I will examine it, supposing water alone is used. Is the scheme any sounder? I think not. There are sorting columns and pipes having $\frac{1}{10}$ in., $\frac{1}{12}$ in., and $\frac{1}{4}$ in. holes. The water flowing through them must be filtered, and be either neutral or slightly acid, otherwise they will choke. This puts the ordinary mine circulating water out of the question and produces further complications. Again, although the author talks of sizing the recovered concentrate for further treatment, he has not shown that he would have to size the whole of the pulp likewise into a number of groups of equal diameters. Equal hydraulic value groups would not in this case be of any value, therefore a lot of machinery would be required.

"Any gold that can reach the amalgamated plate can also be saved by concentrating devices," is not so obvious as the author seems to think. What is obvious is that concentrating devices pick up tons of material, while amalgamating plates are picking up ounces. This may be one of the reasons why Langlaagte Estate, Geldenhuis Estate, and other companies abandoned concentrating plants. If the shaking table device mentioned by the author could not do 100% better as a concentrator than it did as an amalgamator, then it would be useless.[3]

Having come to the conclusion that the author has not advanced anything of practical value, I will mark the sympathy I feel for the attitude of mental discontent he displays, by making the following suggestions for the criticism of himself and other members.

Should it be found on any particular mine, that cyanide solution extracts from the original ore, crushed to sizes within the economic limits of fine grinding, as much of the gold as is recovered by present amalgamation and cyanide methods, then abandon amalgamation. Crush in cyanide gold-free solution, using stamps, classifiers, and tubes, returning all oversizes to tubes by drag or other classifiers. In this way make sure of closed circuit for long contact.

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[1] This *Journal*, Vols. XIII. & XIV., March & Sept., 1913.

[2] This *Journal*, p.p. 141. Vol. XX., Feb., 1920.

[3] Ibid. Vol. XX., Nov., 1919. p. 72.

On the other hand should cyanide not give such a good extraction continue as at present, with the following refinements:—

Abandon the present pulp-thickening cones for real classifiers, capable of grouping particles according to their hydraulic values. (See Professor Stanley's paper on "Classifiers and Classification," and the discussion.[4]). Eliminate from tube overflow all +20 sizes, by trommel preferably, or by Callow screen, so that the closed circuit is avoided. In this way a pulp, containing the value, would be obtained for plate amalgamation, accompanied by deflotation and canvas or corduroy concentration, and so lead to lower residues, the end we all desire.

There being no further discussion, the meeting then terminated.

Obituary.

D. M. FERGUSON.

The death of Mr. D. M. Ferguson, late Assistant Manager, Simmer Deep-Jupiter Mines, took place at Isipingo, on the 5th of September last, after a long and distressing illness.

Donald Meredith Ferguson was only thirty-three years old at the time of his decease, and had worked for about 13 years on the mines of the Consolidated Gold Fields near Germiston.

Starting as a sampler learner on the Simmer Deep early in 1907, in eight years, through strenuous application to duty and steady study, he rose to be Manager of the Jupiter mine.

The deceased was a great example of the eagerly ambitious and studious type of young man, who, without great educational advantages, is determined to progress in life.

The writer has known him since 1907, and has always admiringly wondered at his untiring perseverance and application.

To obtain knowledge of every kind was his aim: most subjects, particularly those connected with mining, were eagerly studied and assimilated.

His death leaves a blank not to be filled amongst his associates on the mines, and it will be long before "Fergie" is forgotten. All on the mine esteemed him, from the humble waste packer to the General Manager, because as a man he was "white," and possessed in an extraordinary degree the gift of "handling men."

Sincerest sympathy is extended to his widow and young family.

He became a member of this Society in November, 1917.

H. K.

Notices and Abstracts of Articles and Papers.

CHEMISTRY.

Selenium and its Applications.—An account is given of the methods in use for extracting selenium from its ores. All the scientific and technical applications of selenium, with one or two minor exceptions, depend upon the increase of the electrical conductivity of the element under the influence of light. The different allotropic forms differ widely in their sensitiveness to light, and attention is particularly directed to the very sensitive variety of vitreous selenium previously described by the author. (*Jour. Soc. Chem. Ind.*, 1915, 379.) Descriptions of different types of selenium cells are given, and of the methods used for determining their sensitiveness. Selenium cells have been used successfully for controlling the draught in factory chimneys. A selenium cell is placed in a suitable position in the chimney, and is illuminated by a lamp situated on the opposite side of the flue. The amount of light falling on the cell, influenced by the quantity of smoke passing between the lamp and the cell, determines the strength of the current passing through the cell, and the current variations are indicated by a recording galvanometer. The same principle has been applied to the control of the manufacture of sulphuric acid by the contact process, the degree of transparency of the gases in the reaction tube being recorded by means of a selenium cell and galvanometer. An account is also given of experiments on the use of selenium cells for wireless telephonic and telegraphic purposes, for determining the position of hostile artillery, for the telegraphic transmission of illustrations and pictures, and for recording variations in the intensity of the light emitted by the sun during an eclipse. Selenium has also been used in place of sulphur for vulcanising rubber, and in glass to obtain a pale violet colour.—L. Ancel (*Chim. et Ind.*, 1919, 2, 245-259.) *Journ. Soc. Chem. Ind.*, May 31st, 1919, p. 321 A. (J. A. W.)

The Sulphuric Acid Industry.—Owing to its connection with the manufacture of explosives, the sulphuric acid industry is one of the most highly developed in the Union. The five firms engaged in it produce about 53,000 tons of sulphur trioxide a year, most of which they consume themselves in the manufacture of explosives, so that in the year 1916-1917 only 2,964 tons of sulphuric acid was available for disposal. The manufacture of ammonium sulphate requires about 2,500 tons of commercial acid yearly and the cyanide process for gold about 1,800 tons of arsenic-free acid. Minor quantities are employed for making superphosphate, for splitting fats, etc. Messrs. Kynoch, Ltd., advertise a chemically pure acid which conforms to the standard of the British Pharmacopœcia.

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[4] This *Journal*, Vol. XIV., May, 1914, p. 445, and Vol. XV., Aug., 1914, p. 34.

Before the war the raw materials were almost wholly imported, the sulphur chiefly from Sicily (Sicily seconds) and as Spanish pyrites. The imports for recent years are :—

	1914.	1915.	1916.	1917.
	Tons.	Tons.	Tons.	Tons.
Rock sulphur, including pyrites ..	3,900	14,000	25,700	18,500
Flowers of sulphur...	1,120	1,140	3,500	900

The increasing difficulty in obtaining sufficient imported sulphur to supply the growing demand has directed attention to South African sources, and large quantities of local pyrites, mainly concentrates from the gold mines, are employed in the chamber process, but at a considerable expenditure for new furnaces. No information is available regarding the possible use of pyrites in the contact process.

Free sulphur, of no commercial value, occurs along the coast around Walvis Bay and Conception Bay, and deposits of unknown value have recently been found near the mouth of the St. John River, Griqualand East. Notwithstanding possible developments, as at Areachap in the Cape, no large deposits of massive pyrites are actually known. There are, however, many unopened gossan outcrops in the older formations, and practically all the gold ores of the country contain from 5 to 35 per cent. of pyrites. While the Main Reef is on the whole poor in pyrites the percentage in the Black Reef is comparatively high, with only a trace of arsenic.

The New Transvaal Chemical Co., Delmore, works up auriferous pyrites to refractory concentrates which are roasted in specially designed furnaces, a process in operation even before the war. Near Germiston, Pyrite Ltd., produced in 1916, 4,300 tons of pyrites (50 per cent. sulphur) from accumulated tailings. At Sabie, in the Transvaal, there are said to be 40,000 tons of tailings and sands which would yield about 1,000 tons of concentrates free from arsenic and antimony and containing about 40-50 per cent. of sulhpur. The same quantity of concentrates could be produced yearly. The New Areachap Copper Mines Ltd., Gordonia, Cape Province, works marcasite (39-48 per cent sulphur), of which 30,000 tons is estimated to be in sight. The Barberton district could produce 1,000 tons of concentrates a month containing over 40 per cent. of sulphur and appreciable quantities of gold.

Should the price of sodium nitrate continue to rise it might be possible to utilise local potassium nitrate, such as that found near Prieska, if the potassium were available as a fertiliser. Lead of high quality is produced at the Broken Hill mine in Northern Rhodesia, and the erection of plant for rolling sheet lead on the Rand is under consideration. Most of the necessary machinery could probably be built locally. A small quantity of the spent oxide from the pyrites burners is converted into basic ferric sulphate for use in the refining of glycerin, and some of the oxide is possibly made into paint. The shortage of drums is not acute, but glass and earthenware containers are very scarce.—(*S. Afr. J. Ind.*, Feb., 1919.)—*Journ. Soc. Chem. Ind.*, May 31, 1919, p. 185R. (J. A. W.)

ANALYSIS OF MAGNESITE.—Five grms. of calcined magnesite or 10 grms. of the natural product is digested with hydrochloric acid, and ammonia added to the hot solution until a persistent turbidity is produced. The liquid is then boiled, allowed to settle, and filtered, the filter ignited, and silica determined in the residue after treatment with hydrochloric acid. In the filtrate, aluminium and iron are determined and in the filtrate from these, together with that from the first operation, the lime and magnesia are determined in the usual way. The magnesium is more conveniently weighed as the double phosphate dried at 100° C. than as the pyrophosphate after ignition. The calcium is preferably precipitated as sulphate in presence of alcohol, or the following rapid method of separating it for estimation may be used : A hydrochloric acid solution of the mineral, containing not more than traces of free acid, is introduced, together with the insoluble residue, into a measuring flask, the volume made up to the mark with water, and ammonia solution added. The flask is then closed and the liquid mixed and allowed to settle, the calcium being determined in an aliquot part of the clear liquid. This procedure gives concordant results which are rather lower than those obtained when the calcium is precipitated in presence of magnesium.—V. MACRI, (*Boll. Chim. Farm.*, 1918, 47, 301-302.) *Journ. Soc. Chem. Ind.*, May 31, 1919, p. 320 A. (J. A. W.)

IODOMETRIC ESTIMATION OF BROMATE AND IODATE.—In the titration of bromate-iodide solution with thiosulphate solution it is essential that sufficient acid be present if titration is performed immediately after the addition of the iodide. A minimum concentration of $N/2$ for hydrochloric acid is required and of $N/1$ for sulphuric acid. When too little acid is present thiosulphate is oxidised by bromate directly to sulphate. The error arising from this cause may be avoided by postponing titration for a few minutes until the reaction between bromate and iodide is complete, or by catalysing the reaction by the addition of ammonium molybdate. This catalyst is effective both in strongly acid and in weakly acid solutions. The reaction between iodate and iodide takes place much more rapidly than that between bromate and iodide, hence the above precautions are unnecessary in estimating iodates iodometrically. — KOLTHOFF, (*Pharm. Weekblad*, 1919, 56, 426-438.) *Journ. Soc. I.M. Chem. Ind.*, May 31st, p. 320-1 A. (A. W.)

CONDITIONS FOR OBTAINING PURE SODIUM CARBONATE FOR STANDARDISING ACID AND APPLICABILITY OF CRYSTALLISED OXALIC ACID IN PLACE OF THE ANHYDROUS ACID AS A TITRATION STANDARD.—If stirred with a platinum wire, sodium hydrogen carbonate is converted quantitatively into sodium carbonate at 250°. Microcrystalline oxalic acid ($+2H_2O$) may be used for the direct preparation of standard acid : its solutions keep their titre if protected from the light. [See *J. Soc. Chem. Ind.*, 1919, October.]—KUNZ KRAUSE and RICHTER, *Arch. Pharm.*, from *Journ. Chem. Soc.* Abstracts, Oct., 1919, p. 423. (H. R. A.)

METALLURGY.

"NICU" STEEL AND ITS MANUFACTURE.—Hitherto, Sudbury ore, containing (average for 1916) Ni 3·25 Cu 1·7, Fe 40, S 25, SiO_2 20, Al_2O_3, CaO and MgO 10%, has been treated mainly as a nickel-copper ore, with the result that the whole iron content has been wasted, while only about 80% of the nickel and 83% of the copper have been recovered. Most of the nickel obtained has been subsequently recombined with iron for the production of nickel steel. In the "Nicu" process the ore is treated as an iron ore containing nickel and copper, for the direct production of an alloy pig-iron which is subsequently refined to produce nickel-copper ("Nicu") steel. The ore, the composition of which is adjusted by proper mixing of the various grades, is crushed to about ½ in. size and roasted, and the product (containing not more than 0·5% S) is smelted with coke and limestone. Up to the present the smelting has been conducted only in electric furnaces, but successful blast-furnace operation is anticipated. The pig produced was at first converted into steel in an electric furnace; but later an ordinary open hearth-furnace was employed under ordinary steel-making conditions, with complete success. In a trial on weathered, low-grade ore containing Fe 46·0, Ni 1·3, Cu 0·28, SiO_2 19·0, and S 8·0%, a pig was produced containing Ni 2·20, Cu 0·40, Mn 0·18, Si 1·75, C 3·0, S 0·09, and P 0·07%, from which a steel containing Ni 2·13, Cu 0·40, C 0·20, Mn 0·51, S 0·03, S 0·03, and P 0·006% was produced in the open-hearth furnace. This steel practically fulfilled the conditions required by the British Government standard 2% nickel case-hardening steel as regards chemical composition and physical tests. Similar agreement was obtained in comparative tests on 3·5% nickel+copper (Nicu) steels and various commercial 3·5% nickel steels; while Nicu steel containing 2·25% Ni and 0·75% Cu was found equal in all respects to commercial nickel steels containing 3% Ni. Nicu steels in which the proportion of copper does not exceed ⅓ or ¼ or the nickel present are the most satisfactory in practice, and the copper content should preferably not exceed 1% if the steel is to be used for the same purposes as the corresponding nickel steel. By the Nicu process, 98% of the nickel, 98% of the copper, and 96% of the iron in the ore are recovered. Without considering the sulphur, of which a recovery of 80% is anticipated, it is estimated that Nicu steel equivalent to 3% nickel steel could be produced at $30·00 (£6 5s.) per ton, whereas the selling price of the latter in normal times is more than twice that figure.—G. M. COLVOCORESSES, *(Trans.-Canadian Min. Inst.*, 1918, 21, 48-75). *Journ. Soc. Chem. Ind.*, May 31st, 1919, p. 326 A. (J. A. W.)

NICKEL COINAGE.—"During the week two significant indications have been given that the doom of silver as the material for subsidiary coin in many countries is imminent. The German Reichsbank is prepared to pay in paper currency for German silver coin six and a-half times its face value, and a bill, styled 'McFadden,' is being introduced into the U.S. Congress to authorise the issue of notes by Federal Reserve Banks, in various denominations down to one and two dollars, the notes to be legal tender for amounts not exceeding 10 dlolars. The Bill also provides for reducing the quality of silver coin to 0·800. It has recently been announced that the silver in Canadian coins is to be reduced to a similar quality. We understand that the new Indian ½ and ¼-rupee pieces are not composed of pure nickel, but of an alloy of nickel and copper, worth about half the value of the pure metal. The intrinsic worth of subsidiary coins is not material. The desiderata are that they should be difficult of forgery, and lasting in wear. Strangely enough, the Indian Currency Act authorised nickel coins, whereas actually nickel alloy has been employed. It is reported officially in Switzerland that the comparative abrasion of various coins was tested by placing equal weights of many varieties inside a drum, which was revolved for 40 continuous hours. The result was as follows:—

	%
10-rappen piece of aluminium alloy	11·27
1-franc piece of 0·835 silver, 0·165 copper ...	7·79
2-franc piece of 0·835 silver, 0·165 copper ...	6·62
½-franc piece of 0·835 silver, 0·165 copper ...	5·77
5-rappen piece of brass (100 rappen=1 franc)	4·01
10-rappen piece of brass (containing 60% copper, 40% zinc)	3·69
5-rappen piece of copper-nickel	3·29
10-rappen piece of copper-nickel	2·45
1-rappen piece of bronze	1·23
2-rappen piece of bronze	1·09
20-rappen piece of pure nickel	0·59

It seems a pity, therefore, that the Indian Government did not decide upon pure nickel, which has also the faculty of retaining its pristine condition to a remarkable degree. The hardness of pure nickel gives this metal many advantages. Owing to the clear-cut effect produced by a die upon this metal, it is almost impossible to manufacture spurious coins. Great expense must be incurred in setting up suitable plant, and intense heat is required to melt and cast the blanks. We are informed that the methods of dealing with it are so perfected that ordinary steel dies can now be used. The 1914 report of the Deputy-Master of the Royal Mint referred to the resistance of pure nickel to chemical attack, and the discovery recently has been made that pure nickel coins harbour far fewer bacteria than those composed of other metals. Like cobalt and iron, nickel is subject to magnetic attraction, but an admixture of only 5 per cent. of other metals deprives it of this quality. Thus the detection of nickel alloy coins is rendered easy. The Swiss Government was compelled to relinquish coining nickel during the war, and resorted to brass scrap, out of which excellent golden-coloured pieces were minted. Iron, zinc and aluminium have been utilised for coinage on the Continent of late, and it has even been stated that discs cut out of tin jam-pots have circulated as money in regimental districts in the East where troops have been stationed."

(Nickel coins can be tested by means of a magnetized knife blade . Nickel coins are discussed in the recent report of the Ontario Royal Nickel Commission, of which the Chairman was the late Mr. G. T. Holloway, Corresponding Member of Council of this Society.—Ed. Comm.)—From SAMUEL MONTAGU & Co.'s Bullion Report dated 22nd January, published in *The Economist* of 24th January, 1920. (W. A. C.)

MINING.

Deep Mining Temperatures on the Rand. The general cooling of an extensive mine would necessitate a very large installation, for direct refrigeration, as the quantities of heat to be got rid of were considerable. The problem had been met with on the Witwatersrand in a rather acute form, and it might be of interest to describe the method in use in the City Deep Mine, which was one of the largest and deepest mines of the Witwatersrand.

The structure of the City Deep Mine was simple enough. The area was roughly rectangular about 12,000 ft. long on the strike and 8,000 ft. on the dip.

At the present time the workings, which were confined to the uppermost portion of the mine, extended over an area of approximately 10,000 ft. along the strike by 3,500 ft. on the dip, and the greatest vertical depth at present was 4,500 ft. On the Witwatersrand the temperature of the rocks increased at the rate of 4 dg. for every 1,000 ft. in depth, and the rock temperature at 4,500 ft. was 84 deg. This would not be at all serious were it not for the fact that the air, shortly after leaving the main intakes, very soon became saturated in consequence of regulations stipulating that all rock surfaces should be kept wet in order to prevent the dissemination of dust. A saturated air at a temperature of 84 deg. F. was scarcely supportable unless the air was in active motion, and this latter condition could not be maintained at every point, particularly in development ends. In this connection it might be mentioned that the katathermometer, designed by Dr. H. Leonard Hill, had been found most useful in translating the physiological temperature state of an atmosphere into a single numerical result, as this instrument not only took into consideration the temperature and humidity, but also the cooling effect due to motion of the air.

They had therefore reached the limit on the City Deep, and had yet an additional 2,500 ft. to go, and were faced with the necessity of reducing the air temperature from between 95 and 100 deg. F. (which it would be at 7,000 ft.) to about 75 deg. F. The principle that was being relied upon was the heat-absorbing capacity of the ventilating current of air due to evaporation and to its specific heat. Local cooling near the bottom of downcast shafts was, of course, taking place everywhere, but it generally remained local cooling only, and in any case could have little or no effect on the temperature of distant parts of the mine, unless the total heat supplied from all sources. In the City Deep this latter condition obtained at the present moment, and there was not the slightest difficulty with temperatures down to a depth of 4,500 ft., but whether the principle would be equally successful at 7,000 ft. remained to be seen. However, practical observations and careful inquiry into the physics of the problem rendered it quite probable that they would be successful. The air became warm after it had travelled some distance from the main intake, but, except in the case of long dead-ends, no difficulty had been found in keeping all the working places at a satisfactory temperature. Dead-ends would have to be cooled by a special ventilating pipe supplying dry air to the face, but the necessity for this had not yet become urgent, as the air at the face, where nearly all the work was done, was effectively cooled by the exhaust from the rock drills.

The heat of the air in the mine came from the following sources:—(1) The compression of the air in its way down the shaft. This was considerable; in fact, the temperature rise on this account was actually greater than the temperature rise of the rock due to depth. (2) The flow of heat from the rock mass to the air of the workings. This depended upon a great many factors, among them being (*a*) the conductivity of the rocks and the temperature difference between the rock and the air current; (*b*) the relation between the volume of the workings and the rock surface; and (*c*) the daily increment of surface resulting from mining. (3) Further sources of heat are water, the men working in the mine, the combustion of illuminants, explosives and electric power. A frequent source of heat supply, viz., chemical change of minerals, is not, in the case of the Witwatersrand, of any importance.

To absorb this heat they were relying upon:—(1) The specific heat of the air, and (2) the heat absorbed by its evaporative power. It was very fortunate that in the Transvaal the air during the greater part of the year was dry, the percentage of humidity ranging between 74 per cent. during the rainy season and about 36 per cent. during winter, and it was this fact which rendered the method practicable, and might possibly afford a complete solution of the difficulty. The capacity of the fan was, as previously stated, 400,000 cub. ft. per minute, and the average heat-absorbing power of this quantity of air was 1,700,000 calories per second. Of this amount one-fifth was due to the specific heat of the air and four-fifths due to evaporation. On account of the dynamic heating, they lost, in the deepest part of the mine, practically the whole of the heat-absorbing capacity resulting from the specific heat, but as the air rose to the shallower parts of the mine, some of this was returned. In the calculations the abstraction of 1,360,000 calories per second was all that was relied upon. The items under the heading (3) amounted to about 185,000 calories per second, leaving a balance of roughly 1,200,000 calories per second available for absorbing the heat from the rocks. Assuming that the mine was bounded by an infinite mass of rock, and assuming that the estimate of conductivity, which was based on experiments, of 0·0093 was correct, this quantity of heat was greater than the heat-flow from the rocks of an air current of a temperature of 75 deg. F. Under the present conditions therefore, the mine would tend to become cooler as a whole, but the continuous increase in the extent of the mine was having the opposite tendency.

The process was self-regulating to a considerable extent, because the heating of the air increased its evaporative power, and there was abundant moisture everywhere for the exercise of this power, and also in consequence of the dynamic cooling as the air travelled from the lower to the upper parts of the mine. It was important to keep the downcast shafts as dry as possible, in order to preserve as much evaporative capacity as possible for use in the distant parts of the mine. In practice, this led to a little difficulty in controlling the temperature, as the air was apt to become too cold just after it left the main intake if there was an abundant supply of moisture, and, on the other hand, it became too hot where the current was sluggish. Control was generally effected without much difficulty in either case by regulating the quantity of the air and restricting the supply of moisture. The dynamic cooling admitted of a very simple type of ventilating scheme. All that was necessary, so far as the temperature was concerned, was to keep the downcast shafts dry and bring the main supply of fresh air to the deepest part of the mine. If its condition was made satisfactory at this point, it was not likely to become unsatisfactory higher up in the mine. A further effect of the dynamic fall in temperature was to bring about a condensation of moisture, making the air extremely foggy in the upper parts of the mine, and it had this incidental and unlooked for advantage, that the air became completely cleared of dust particles. —E. H. Clifford, *Iron and Coal Trades' Review*, Aug. 1, 1919, p. 147. (J. A. W.)

MISCELLANEOUS.

Neutralising of Acid Mine Water on the Witwatersrand and Settlement and Treatment of Sludge Formed Thereby.—All the mine waters of the Witwatersrand are acid, from Randfontein to and including the E.R.P.M. mines. From thence, eastward, it is not unusual to find the water neutral or slightly alkaline, as at New Modderfontein, Modder B., and Modder East, due to presence of bi-carbonate of lime derived from water issuing from the dolomite formation.

The following table serves as an illustration of the amount of water pumped and acid content, of a few of our mines :—

Mine.	Gallons pumped daily.	Acidity (in term) of Sulphuric Acids before Neutralising. Per cent.
Village Deep	700,000	0·01
Ferreira Deep	260,000	0·06
Durban Roodepoort Deep	500,000	0·02
Robinson G.M.	330,000	0·02

The following constituents are generally contained in mine water :—

- Free sulphuric acid.
- Soluble silica.
- Ferric sulphate.
- Ferrous sulphate.
- Aluminium sulphate.
- Sulphates of calcium, magnesium and alkalies, together with chlorides.

In the treatment of the acid mine water the following four objects may be held in view :—

(1) The efficient and economic neutralisation of the free acid (sulphuric) and of the acid ferric sulphate, to prevent pipe and pump corrosion.

(2) The settlement underground of the solids suspended in the water so as to deliver reasonably clear water to the pumps in order to avoid excessive abrasion and choking of pipe lines.

(3) The complete neutralisation of free acid, precipitation of ferric and ferrous sulphate and sulphate of magnesium and settlement of the precipitated salts to render the water suitable for use in the reduction works.

(4) Neutralisation of the free acid accompanied by settlement or filtration, to render the water suitable for use and re-use in underground spraying and washing in accordance with Government Regulations.

Neutralising Re-agents.—The neutralising reagents in current use on the local mines are carbonate of soda (Na_2CO_3), unslaked lime (CaO), slaked lime [$Ca(OH)_2$], and pulverulent carbonate of lime ($CaCO_3$).

Use of Soda.—The soda used until recently has been in the form of crude soda obtained from a natural deposit in the Pretoria district containing 60 per cent. of Na_2CO_3, the balance being chiefly water of crystallisation and detritus of the deposit.

Calcium Carbonate.—This reagent is a natural pulverulent form of carbonate of lime, found in extensive deposits in several parts of the Transvaal. Examination of a representative sample shows a $CaCO_3$ content of 90 per cent., grading 91 per cent. passing a 200-linear mesh screen.

Use of Lime.—The neutralisation of the free acid and acid ferric sulphate can be obtained with lime, preferably with hydrated air separated lime.

For reduction works purposes, the portion of the mine water used in the replenishing of the mill water circuit should not only be completely neutralised but further purified (3), *i.e.*, in addition to the free acid being neutralised and ferric sulphate precipitated, the ferrous salts and magnesium salts should be precipitated and then settled in a tank or a dam on the surface. For this, the use of lime is most economical. Where all the mine water runs into the mill storage water dam, sufficient lime from some source should be added to efficiently effect the above. The approved practice is to treat only such a volume of water as is necessary for surface services.

A satisfactory method of controlling air separated lime feed is by means of the specially designed feeder (flour mill type).

An analytical examination of average hydrated air-separated lime gives the following data :—

Grading :

+60 mesh	+90 mesh	+200 mesh	−200 mesh
1·18%	2·82%	4·38%	91·62%

(*a*) Available lime (CaO) soluble in water ... ... = 59·7%
which is equivalent to $Ca(OH)_2$ ... = 78·9%
(*b*) Insoluble in water residue ... ... = 21·1%

An analysis of the insoluble residue (*b*) is as follows :—

Insoluble in acids :—
Carbon (free) ... ... = 1·4%
Siliceous residue ... ... = 17·6%
Soluble in acids :
Iron oxide and alumina ... ... = 11·0%
(Fe_2O_3) (Al_2O_3)
Lime (CaO) ... ... = 37·0%
Magnesia (MgO) ... ... = 18·9%
Carbon Dioxide (CO_2) ... ... = 14·1%

The precipitated sludge with its admixture of mine washings varies greatly in composition and physical characteristics, according to the degree of such admixture. The following determinations were carried out for further information :—

Insoluble in Acid.
(*a*) Durban Roodepoort Deep sludge ... 32·6 %
(*b*) E.R.P.M. sludge ... ... 72·17%
(*c*) City Deep sludge ... ... 82·30%

Cyanide Extraction Test on (*a*) Sludge.
Assay of original ... ... 1·04 dwt.
Residue ... ... 0·45 dwt.

Extraction ... ... 56·8%

Lime consumption ... ... 75 lb. per ton.
Cyanide consumption ... ... 13·6 lb. per ton.

Evidently it is questionable practice, to say the least, to send such material to cyanide works.

F. Wartenweiler and E. H. Crogan, abstracted from *The Journal of the South African Institute of Engineers*, Vol. XVIII., Oct., 1919, No. 3. (H. R. A.)

Abstract of Patent Applications.

703.18. Luckenbach. Processes Incorporated. Mineral selective and frothing agent and processes or methods of producing and using the same. 23.11.18.

This application is for a process patent for the use of a speciol oil and/or combination of oils in the flotation process.

The applicant has found that oil derived from greasewood has a peculiar selective action for such minerals as carbonates of zinc, of copper and of lead; silver lead sulphides; oxides of iron and silicate of copper, by which these minerals are recovered in the standard flotation machines. The applicant has found that the greasewood oil must be prepared in a certain particular way, and has also discovered that the mixture of greasewood oil with the ordinary flotation oils results in a higher recovery of minerals in the flotation process.

793.1918. W. F. Hosking. Cylindrical or tubular saw. 27.12.18.

This application is for a tubular saw, specially designed for grooving and recessing mine poles or lagging for use in the mines in connection with the erection of pigsties for the support of hanging where the poles require to be interlocked and placed on the top of each other.

48.19. Central Mining and Investment Corporation, Ltd. Improvements in the electrolytic recovery of metals from their solutions. 22.1.19.

The application consists of first de-oxygenating the metal bearing solution, and then delivering same to a press of the general type described in patent 161/15, in which the metal is separated from the solution by being passed through an energised permeable cathode. The latter may be made of paper in which graphite is incorporated as described in application No. 49/19.

The improvement claimed is for the removal of oxygen from the solution before electrical precipitation in which the metal bearing solution is passed through a permeable cathode of fine porosity.

49.19. Central Mining and Investment Corporation, Ltd. Improvements in electrodes for electrolytic recovery of metals from solutions. 22.1.19.

The application is for a permeable cathode for electrolytically precipitating metals from their solutions, and is an improvement on those described in patents Nos. 341/13 and 338/11. The cathode consists of a sheet of paper or felted fibre in which comminuted conducting material such as graphite is incorporated.

The claims are seven in number, and are confined to permeable electrodes made of paper or felted fibre in which a comminuted conducting material is incorporated and the method by which one variety may be made.

173.19. G. B. Brown. Improvements in process and apparatus for electrostatic separation for finely divided discrete material. 12.3.19.

This application has reference to process and apparatus for the separation and classification of particles of metal bearing ores.

By this process the finely divided metalliferous material is heated and subjected to electrostatic influence, being fed on to the electrodes by centrifugal force.

The claim especially made for the process is in respect of the drying or heating of the particles before being brought into the electrostatic field.

The apparatus consists of a revolving feeding hopper mounted on a hollow vertical shaft which has a pan connected to its lower end, the material being fed through ports in the hollow shaft into the pan. The rim of the pan is the earthed electrode. The other electrode is adjustable, and consists of a ring spaced above the rim of the pan. The pan is electrically heated. The dividing disc having circular hoppers is placed outwardly of the electrodes and may form part of the bottom electrode. A discharge hopper revolving in the opposite direction extends from the dividing disc to a second hollow shaft. The whole is cased in and provided with air ports at the top and a suction device at the bottom of the hollow shafts.

189.19. K. B. Quinan. Improvements in or relating to the production of nitric acid. 19.3.19.

The applicant claims certain improvements in the synthetic production of nitric acid. Although the applicant puts forward seven different claims, they are only more detailed descriptions as to how to carry out the process.

198.19. C. H. Smith. Furnace Retorts. 21.3.19.

This application relates to a combined retort and furnace for the distillation of coal continuously.

It consists of a shell, the innermost portion of which includes hollow carborundum tiles which provide combustion flues, surrounded by a heat-storing material such as fire brick, with an outer metallic shell, lined with a heat insulating material such as asbestos.

The retort portion has a heart-shaped cross section to contain a pair of paddle shafts, with blades attached for the double purpose of acting as conveyors and cleaning each other from the heated material clinging thereto.

227.19. C. H. Smith. Carbonizing furnace retorts. 31.3.19.

The application is for a carbonizing furnace retort to make briquets from raw, or partially carbonized coal, using tar or pitch as a binding material. The applicant does not claim the use of tar or pitch as a binding material, which is universally used, and only claims this particular furnace, as in the drawing.

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KENNEY, H. S., *l/o* Dersley; Ottoshoop, Transvaal.

MACER, L. W., *l/o* S. Van Ryn Reef, Nigel: Luipaardsvlei Estate G.M. Co., Ltd., P.O. Box 53, Krugersdorp.

ROWE, A. S., *l/o* Wankie Colliery; Rezende Mines, Ltd., Penhalonga, S. Rhodesia.

WILLIAMS, MAJOR G. W., M.C., from Active Service; 36, Acacia Road, St. John's Wood, London, N.W., 8.

THE JOURNAL
OF THE
Chemical, Metallurgical and Mining Society
OF SOUTH AFRICA.

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Vol. XX. APRIL, 1920. No. 10.

Proceedings
AT
Ordinary General Meeting, April 17, 1920.

The Ordinary General Meeting of the Society was held in the South African School of Mines and Technology Building, Johannesburg, on Saturday, 17th April, 1920, Mr. Jas. Gray (President) in the chair. There were also present:—

28 Members: Messrs. J. Chilton, G. A. Watermeyer, C. J. Gray, J. H. Johnson, J. J. R. Smythe, J. R. Thurlow, T. G. Trevor, H. S. Meyer, Prof. J. A. Wilkinson (Members of Council); P. Cazalet, Prof. J. Cellier, P. Friedman, W. S. Gordon, L. D. Hingle, Sir R. N. Kotze, J. D. Marquard, J. M. Neill, Dr. A. J. Orenstein, A. E. Pulford, Dr. A. W. Rogers, F.R.S., S. H. Steels, J. Thorlund, W. E. Thorpe, C. Toombs, J. Watson, H. R. S. Wilkes, A. Willcox and J. A. Woodburn.

3 Associates: Messrs. E. P. Cowles, C. L. Dewar and J. Gibson.

6 Visitors and H. A. G. Jeffreys (Secretary).

MINUTES.

The Minutes of the Ordinary General Meeting, held on 20th March, 1920, as recorded in the March *Journal*, were confirmed.

NEW MEMBERS.

Prof. J. A. Wilkinson and Mr. J. R. Thurlow, having been elected as scrutineers in connection with the ballot for the election of new members, the following were declared unanimously elected:—

Addie, John Kenneth, General Manager, Witbank Colliery, Ltd., Witbank. Mining Engineer.

French, Arthur, P.O. Box 1242, Johannesburg. Manager, General Mining & Finance Corpn., Ltd.

Lawn, James Gunson, P.O. Box 590, Johannesburg. Mining Engineer.

Parry, John, The Laboratoy, De Beers Consolidated Mines, Ltd., Kimberley. Analytical Chemist.

Willey, Joseph Leonard, P.O. Box 3, Brakpan. Metallurgist.

Wilmot, Louis Boniface, 30 Oceana Bldgs., Simmonds St., P.O. Box 2106, Johannesburg. Engineer.

OBITUARY.

The President: I regret to announce the death of Mr. John Stuart MacArthur, an Hon. Member of this Society for many years. As you are aware, Mr. MacArthur, in conjuction with Dr. Forrest invented the Cyanide Process for the recovery of gold in 1887, which was successfully introduced on the Rand in 1890. It is a platitude to say the Cyanide Process revolutionised the metallurgy of gold. I would ask you to rise as a mark of respect to his memory.

All members present rose to their feet.

JOINT HOUSING SCHEME.

At our last meeting it was reported that the first step in connection with the scheme for joint housing had reached a successful termination, inasmuch as a "home" had been obtained. To-night we come to the second stage—that is, the launching of a financial campaign for the purpose of raising the necessary funds to render the building habitable and suitable for the work of the Technical Societies.

This Society, as a constituent member of the Associated Scientific and Technical Societies of South Africa is approaching its members to assist in raising a sum of about £4,000, which is required immediately for executing repairs, for the purchase of necessary furniture, payment of transfer fees, and legal expenses, and sundry other matters.

I desire to move the following resolutions for your consideration, and, I hope, approval:—

(1). That this General Meeting of members hereby accords its most hearty approval of the action of its Council in agreeing to the recommendations of the Joint Committee of the Closer Working of Scientific and Technical Societies with regard to the purchase of the Johannesburg Club as a joint home for the work of the Societies, and, at the same time, requests the Council on behalf of the Society to do all in its power to further that object.

(2) That this General Meeting of members hereby approves the recommendation of the Council in voting the sum of £150 from the funds of the Society as a free gift to the Associated Scientific and Technical Societies of South Africa.

(3) That this General Meeting approves of an appeal being made at once to the members of the Society in order to assist this object with a request for donations from individual members of one pound or more.

I may say the Council has decided amongst themselves to raise as large a sum of money as possible. In that connection, I have very great pleasure in announcing that three donations of ten guineas have been promised, or received already.

We have present to-night our representatives on the Joint Committee, as well as representatives of other Societies, and I will leave it to them to place the full position before you.

Mr. John Watson *(Member)*: I have very much pleasure in seconding the resolutions. I was a member of the original Sub-Committee for some time with Mr. H. S. Meyer, and I am now glad to find the matter is bearing fruit.

Prof. J. A. Wilkinson *(Past President)*: I hope the resolutions which have been placed before you this evening will meet with your unanimous support. The labours of the Committee, which has now been working for five years on this subject, have at last borne some fruit. Within another six months all the various Societies which have participated in this early movement will find a home—something more than a home, that which is implied in the term which has hitherto been used in the name of the Committee, namely, closer working.

The position at the present moment is as follows. The old Johannesburg Club, which was considered to be a very suitable place for our purpose, was in the market, and two or three members of the Joint Committee interviewed the owners and were given an option for one week. During that week many meetings of the Closer Union Committee took place, and the outcome was that the offer of the Chamber of Mines to assist this scheme at its inception was taken advantage of. I may say, however, that the offer of the Chamber of Mines—magnificent as it was—was given in the hope that members of the Scientific and Technical Societies would help themselves. It is on this account that this matter comes before you this evening.

When the Closer Union Committee started work, we had not very much knowledge as to what would be required; but our ideas grew, to what you have already heard in Mr. Cazalet's paper read before this Society some time ago: that we should attempt to get an endowment as well as a home and a building.

The object of that endowment was to pay the current expenses of running the joint Union. At the present moment, we are not in that happy position, but we hope to be in that happy position as we get older—and, I hope, before we are very old. There is no doubt that it is the proper way to run such a scheme as this; otherwise it means that there is a continual drain on the funds of the various Societies in order to keep the scheme alive.

I do not think I should be divulging any secret if I were to tell you that it is still the object of the Committee to try if possible to get an endowment; but, at the present moment, we are saddled with a debt of £22,500. In order to take advantage of that sum of money, free of interest for two years, we have to raise, as your President has already told you, about £4,000. The object of raising that £4,000 is so that we can enter into possession of this building, use it as a meeting place and also partially as a Club, where members of the Scientific Societies can meet together, where any member of any Society which is a member of the Closer Union can see and also take an interest in what other Societies are doing. It has long been felt on the Rand that Societies are isolated, individual units which do not take any interest in or care for the work that each of the others is doing. Now, to many of us this has been deemed to be wrong. There is no doubt that many members of this Society are interested in the work of the other Scientific Societies on the Rand, and, if they knew what was taking place at those Societies, I feel perfectly sure they would show their interest by attending their meetings. That is one of the purposes for which this Joint Home will serve.

Since the Joint Closer Union Committee entered into this scheme, the various members of that Committee representing the different Societies have felt in their own minds that it is now time for the Societies individually to be up and doing. Some have felt this more than others. In some Societies there is a great deal of difficulty over the disposal of their funds for this particular object. In two Societies, however—the two Engineering Societies here—the move has already been taken and the members of those Societies are extremely enthusiastic as you will observe and realise when I tell you that already they purpose to donate, comparatively speaking, a large sum of money from their funds—£500 in each case, as a free gift, and, at the same time, they have undertaken to raise amongst their members a further sum of about £1,500. Now, we do not want to be left behind. The widow's mite is just as good as the millionaire's million, provided it is given in the same spirit and with the same enthusiasm. We cannot give £500 as a free gift; but, after studying the financial position of the Society as it exists at present, your Council feels that it is possible to donate a sum of £150 from the funds of the Society, as a free gift to the Closer Union in order to contribute towards the funds which are necessary to set it going. That is the second resolution which has come before you.

Since the Society has done, if you sanction it, what it can out of its funds for the furtherance of this particular object, it now remains for each one of its members to do his little bit; that is the object of the third motion.

We have in the Society, at the present moment, about 400 paying members; of these there are approximately 290 on the Reef. Amongst these we can, or at least we ought to be able to raise roughly a sum of between £250 and £300. If we can send forward £150 from the Society as a free gift and also at the same time, a sum of from £250 to £300 also as a free gift, I think we shall be showing to the best of our ability as much enthusiasm and as much spirit as has been shown by the other Societies.

I trust, therefore, that these resolutions will meet with the absolutely unanimous approval, not only of this meeting but also of the members of the Society who do not happen to be here this evening. I may say that already a member outside the Reef the other day sent his subscription and stated in his letter:—"You will be wanting money for this object. It is a good object; and I herewith send you the sum of £5. After deducting the sum which is required for my subscription, please donate the rest to the Closer Union." Now, if we can get that spirit throughout all our membership, we shall have no difficulty whatever in raising the sum of £250 to £300; and, if we do that, as I said before, I think we shall be showing the other Societies that we also have done our best. I have very much pleasure indeed in supporting these resolutions, which have been proposed by your President.

Mr. H. S. Meyer (*Past President*): As the other member of your Sub-Committee which has had the privilege of bringing our objects to this very happy conclusion—I do not want to cover the ground Prof. Wilkinson has so ably handled—I can assure you that he made a very good point in touching on the need for co-operation. It is only when one has been sitting at frequent meetings with members of practically every kind of Scientific and Technical Society that has its main sphere of activity on the Rand, that one realises the extraordinary close connection that we have with each other, and how much we have in common. As time goes on, this has convinced me more and more of the need for this joint housing and co-operation between the Scientific and Technical Societies. The arguments Prof. Wilkinson has so eloquently placed before you are so obvious that I do not propose to waste your time by going over them again, but, if we do not take this opportunity and put our best foot foremost, we shall regret it for the rest of our lives.

Mr. P. Cazalet (*Member*): Mr. President and gentlemen, I hoped, Mr. President, you would have left calling on me until a little later in the evening, because I might then have been able in my remarks, to cover any questions members might have asked, especially on the subject of further detail; but, if that is desired, I can do so subsequently.

First of all, I would like to thank you, Mr. President, for the very nice words you said with reference to the part taken by me in this business, at your last meeting, which I have only just had an opportunity of reading in the *Journal* to-day. I think it was very kind of you to say what you did, but I think it was also quite unnecessarily personal, inasmuch as we have had a Committee of representatives of 10 Societies who have done an enormous amount of work, and it is always invidious to select any individual and refer to him particularly. It just happens that through my bad luck the rest of the Committee selected me as their Chairman and put a good part of the work on to my shoulders.

I may say at the outset that the Joint Committee has approached the Carnegie Foundaion in America for assistance, and has explained the situation very fully to them, but I am sorry to say that only by last mail we have had an answer regretting their inability to assist us. A member of the Joint Committee is proceeding to America very shortly and has undertaken to put the case personally before them. We hope that the fact that the scheme is no longer academic, but is now practical politics, may influence them to reconsider their decision. In addition we have written to all the successful American engineers, formerly employed on the Rand, soliciting their financial support. Some answers have been received, and we hope that when the others reply that their answers will be as sympathetic as those already received.

Regarding Professor Wilkinson's remarks as to what the other Societies have done, it should be made quite clear that the two Societies more particularly referred to have still to hold special meetings to sanction the gift, but I think you can take it for granted that both the S.A. Institute of Engineers and the S.A. Institute of Electrical Engineers will each present £500 from their funds, and will each set out to collect the further £1,500 to £2,000 they are aiming at. Perhaps the ambition that this Society has set itself, as regarding collecting from its members may be a little low, and I hope you will succeeed in beating your own modest estimate. Prof. Wilkinson has outlined the facts leading up to the purchase of the building, and there is no necessity for me to enlarge on them. The particulars of the generous offer of the Chamber of Mines have also already been laid before you. Though this business has not yet been completed, we have been promised £12,500 on first mortgage at 6½%. Until the purchase is completed and transfer effected we have to pay interest on £22,500, at 7%, amounting to between £130 and £140 per month, and the sooner we get the incorporation through the better so as to enable the Chamber of Mines' guarantee to pay the interest started. Then, there is the cost of putting the building into habitable repair; redecorating, repairs and furnishing. The Joint Committee's estimate for the whole of these liabilities amounts to roughly £4,000. If the other Societies connected with the matter support the proposals in the same generous manner as this Society and the other two mentioned, I think there is no doubt whatever that we ought to be able to raise the £4,000 in a very short time.

The present building will give accommodation for Meeting Rooms, Reading Rooms, rooms for the administration of the Institute itself—not of that of the individual Societies—and possibly to a limited extent for a certain amount of eatering as, for instance, mid-day lunches and teas. You will doubtless all desire the actual housing of the Societies' offices in the building and the proper provision of normal Club facilities as a regular Club, and it will then be necessary to add a further two storeys to the building, the estimated cost of adding which and furnishing them is roughly £15,000. The raising of the sum of £15,000 must therefore be contemplated in the future as well as a sufficient amount to pay off, at least, the first mortgage, and also of raising what Prof. Wilkinson called attention to as a necessity, that is funds for the endowment of the building. It appears then that in raising £4,000 immediately we are not by any means covering the whole amount, which we shall have to meet in the future, so it is obvious that having proved what our Societies can do themselves we shall have to go beyond the Societies and attempt to get support from other people. It is, in my opinion, a moral claim on every individual Scientific, Technical and Professional man, who is connected with the movement to-day to give as much as he is able and we shall then be in a position to go outside and say, "We have done what we legitimately can amongst our own members," and can with a good grace call on other people with local interests to give us their financial assistance.

The Chamber of Mines offer of a gift of £5000 if we can raise £10,000 ourselves, or, proportionately less according to what we raise, enabled us to get started and gave an excellent lead.

The financial position summarised is:— The building cost £22,500; to this must be added several hundred pounds for transfer, commission on raising the first mortgage, as well as interest until incorporation takes place. The Chamber has covered the interest for the first two years; subsequently to that we shall have to find that money ourselves, or pay off a proportion of the mortgage which is obviously the better course. I think you can count on from, say, £700 to £800 a year more or less in perpetuity as income from the shops in the building which ought to let continuously and well. Rents will thus meet about half the interest expenditure on the building.

I should like to make it clear what was in the minds of the Joint Committee when they involved you in this big business transaction as it has been made clear to the other Societies. The nature of the business made it impossible to consult the Societies as they are now being consulted. Consultation meant delay, and you would have lost the chance of a Joint Home and Joint Working. Therefore, I feel confident that the Joint Committee took the right action in doing as they did; but they did it with their eyes open in that they were acting without the direct permission of their Societies in involving them in financial obligation.

The objects of closer working have been already dealt with fully by former speakers. I do not think I need say more than this, that other forms of industry are extremely well organised; are extremely vocal, shall we say, and are very definitely consulted in connection with the legislation of the country. To-day, as always in the past, professional, scientific and technical men as such are not and never were consulted, as to how the country should be run. Individuals, yes; but the joint views of the professional, scientific and technical men are never heard in any matter. Now, obviously if you do get a joint home in which all the Societies are housed and meet it is quite obvious that we can get our voice heard and the scientific men's views adopted much more easily and in a very much more definite form than any individual man or a single Society can be heard. Therefore that, to my mind, alone justifies the attempt to gain this joint housing and this joint working of the Technical Societies.

I would like to add also before closing, that no individual Society need feel in any way that that individual Society is being swamped. The Constitution which has been adopted for the Institution which is now in course of being incorporated, and which had to be adopted and passed for incorporation quickly, so as to save the very big expenditure of interest, has made it definite that the management of the individual Societies will remain just as in the past with those Societies. Further, that this joint home which is being secured and which is going to be, to my mind, such an enormous help to us, is going to be run on behalf of the individual Societies owning it by representatives of those Societies nominated by the Societies. Each Society will nominate its own representatives on the Executive Council of the Institution and that Executive Council will have complete control and management of the thing; or, in other words, the Societies will, through their representatives, retain joint control of the management of the joint home, and, at the same time, maintain complete control of their own internal and private business. So there need be no fear whatever of any Society being swamped or being coerced into actions which they feel would not suit their requirements. By this attempt at closer working you get all the benefits, as far as I can see, of such a closer working scheme without the dangers, disadvantages or fears of being swamped in your own particular interests by the voices of other Societies. So I think the members of this Society, as of other Societies, can feel that the Joint Committee has really watched their interests most carefully and has secured the possibility of joint action, of joint housing and of a proper atmosphere in which men of all ranks, from the highest to the lowest, in professional, scientific and technical vocations can meet and discuss matters which are of any interest to all of them on an absolutely level footing. Any one member of that joint home will be on exactly the same basis as any other member; he will have just as much right there, just as much freedom of voice, and just as much right to air his views, be he the most junior member of his profession, or the most senior; there will be no need for nervousness on the part of the younger or aggressiveness on the part of the senior member in ventilating his views; they will both be able to discuss matters openly and freely. I am convinced that both junior and senior members will gain benefit from personal contact on a complete footing of equality which it is so difficult to secure at the present time.

I think that is all I have to say, Mr. President, but I am of course prepared to answer any questions members may wish to put.

Mr. G. A. Watermeyer (*Vice-President*): It does not require much from my small voice to endorse what has been said by previous speakers. The advantages of this joint home are obvious. If we pull together and put in all that we possibly can, we shall never regret it. In this connection, I might well quote the motto of the old Transvaal Republic: " Eendragt maakt magt." You will remember also the illustration of the insurance society, where Hercules is trying to break the bundle of faggots; individually they are very easily broken, but tied together it is almost impossible to break them. We must do our level best to eclipse Prof. Wilkinson's estimate of what we can put forward in this scheme, and our vote this evening should be unanimous on this subject.

Mr. C. J. Gray (*Member of Council*): The Society, I take it, is committed to the scheme. Its members will be dishonoured with the members of the other Scientific and Technical Societies on the Rand, if the scheme is allowed to fail. We can do nothing less, with honour, than adopt the proposals which have been placed before us this evening.

Dr. A. J. Orenstein (*Member*): I did not come prepared to speak on this matter which has been so fully covered by what has been said. However, there is no doubt one could wax eloquent on the value of the united voice of the Scientific and Technical men. There is no doubt at all, as I happen to have seen in Prof. Lehfeldt's paper published in this morning's *Rand Daily Mail*, that we people who live on a fixed salary make but a small show. I think the scientific man is on the periphery of the wheel. As a corporate body and as a part of the community, I take it, in modern life the technical men are probably the most important section of the community. There is no doubt at all about it that all our modern development since man first found out that wheels run quicker over the ground than do stones dragged along, is due to the application of brains. I think the reason why scientific bodies have failed to make themselves heard lies in the fact that they have never really endeavoured to do so. A similar movement which, I think, embraces all the Engineering Societies in America is just about to be consummated. As you no doubt know, the conservative and very good periodical *The Engineering and Record News* of America thought so highly of it that they devoted to it their outside cover advertising space; they stated that they consider it the greatest development of modern times. We are going further than the Associated Engineers of America; we are taking in not only Engineering Societies but all Scientific and Technical men. I think that is quite right, because there is hardly any activity in the scientific world which is not to some extent, if not to a great extent, interdigitated with other scientific activities. Our members here recognise it and in the ranks of our Society's membership are mining men, pure chemists, metallurgists, medical men and mining business men, etc. I think it is very desirable that it is so. I think the real father of this movement on the Rand is the Chemical, Metallurgical and Mining Society which was the first to recognise the need for federation amongst technical men.

There is another point which has been mentioned. There must be a good many members in every technical and scientific body who cannot afford to pay down a lump sum towards the scheme in view. Perhaps we could pledge ourselves to give a small sum monthly or periodically. This may bring forward a greater response. Those of us who cannot put down £50 may be able to give £2 a month for 25 months, or something of that sort. Unless we do try and help ourselves we have no moral right to go to outsiders and ask them to help us. I think that is clear.

Sir Robert Kotze (*Member*): I do not know that I have very much to say on this subject. I have not taken an active part in the discussion or in the work of the Committee; but I have always taken an interest in this matter. The discussion was not started quite recently; it has been talked about among us for a number of years, but the ideas we had in our minds required somebody to come along and carry them into effect. That has now been done. I think if what we hope for comes about, that there is really union of the Societies and we can speak with one voice, then there is no doubt we can not only make ourselves heard but felt in this country, especially when one sees every time that the people who are making themselves felt are those who organise, not only amongst trade unions, but also in the political world. I think by the housing of all the Scientific and Technical Societies in one building and being thereby enabled to speak with one voice when occasion requires—it may not be very frequently required—we shall effect far more than we have ever done before.

The President: Many of us are members of other Societies. We may desire to put our main contribution through one Society and probably a smaller contribution through another Society; or we may desire to divide our contribution between three or four, according to the number of Societies to which we belong. There is no objection to that procedure but it is hoped that donations will be generous. If there is no further discussion or amendment, I will put the resolutions to the meeting.

Declared carried unanimously.

The President: It is a matter for congratulation that we have carried these resolutions to-night. Having done so, the resolutions remain pious hopes unless we take steps to put them into effect. I would suggest that a Committee be appointed.

Mr. H. S. Meyer (*Past President*): I suggest that representatives be appointed from the Far East Rand, Middle Rand, Near East Rand, Central Rand, Near West Rand and Far West Rand.

After further discussion, it was agreed to leave the selection of these representatives to the Finance Committee.

MERCURIAL POISONING.

By Dr. A. J. Orenstein (*Member*):

Dr. A. J. Orenstein (*Member*): The paper I am about to read is a private memorandum which was passed on to this Society through the courtesy of Sir Evelyn Wallers to whom I addressed it, as a result of the matter being brought to my attention in the course of a meeting of the Technical Committee of the Rand Mutual Assurance Committee.

"At yesterday's meeting of the Technical Sub-Committee of the Rand Mutual Assurance Co. a communication received from the Assistant Secretary, Department of Labour, Chamber of Mines, containing recommendations made by a Committee consisting of members of the Chemical, Metallurgical and Mining Society and representatives of the Reduction Workers' Association was discussed.

With all but one recommendation I am in entire accord, but I wish to invite your particular attention to this recommendation which is substantially as follows:—

> "That men engaged in handling mercury, or exposed to fumes from mercury, should either have their tasks substantially reduced, or that *frequent interchange* be made between such men and men engaged in other departments of the reduction works."

I consider that the recommendation that workers be periodically interchanged is not based on sound appreciation of all the factors involved. Furthermore, in the absence of definite evidence that exposure to mercurial fumes is more hazardous than absorption of mercury from the hands and arms, or ingestion of mercury carried to the mouth by the hands or on food, I am strongly inclined to the opinion that the hazard, considering the whole body of reduction workers, is greater from carelessness in cleansing the hands thoroughly after handling mercury than from mercurial fumes, exposure to which is only for a comparatively short time, intermittently and by a small proportion of the workers, and the hazard of which can be largely overcome by such measures as are installed on several mines and are well known to all reduction officials. It is well known, of course, that mercurial poisoning can occur as a result of inhalation of volatilised mercury, but what is not appreciated by many mercury workers is that mercury in its metallic form, when rubbed on the skin, is easily absorbed, and that it can also be ingested by handling food with mercury—covered hands, or even by carrying the mercury-soiled hand to the mouth for such purposes as wiping the lips, etc. To my mind there is very little doubt that the bulk of mercurial poisoning—which, by the way, is very rare indeed in pronounced form—can be prevented by carrying out the recommendations made to the mines several times that running hot and cold water, hand brushes, and good soap be provided in plate houses, and that means be adopted to induce the workers to cleanse their hands thoroughly after handling mercury. This is the first line of defence, and the second one, of course, is the carrying away by ventilation and special devices (of which there are several) the fumes from steaming plates and retorts.

If one accepts the argument that cleanliness after handling mercury is the most important defensive measure, it follows that this is a matter primarily of educating the individual worker, and, if this is so, it follows as a corollary that frequent interchange of workers will tend to weaken this line of defence by making it necessary to educate and re-educate a shifting and much larger body of men."

Perhaps this paper makes a number of categorical statements and it might be as well for me to explain, perhaps, certain of the points arising therefrom. The action of mercury on the human body is probably better understood than that of any other drug, because it has been used for many years in the treatment of syphilis. It is well established that about 20 grains of metallic mercury ingested per diem will, in the course of a comparatively short time, cause symptoms of mercurial poisoning in the average man. It is also well established that metallic mercury combined, of course, with grease in the form of an ointment—any old grease—that 20 grains (a drachm of ointment) of mercury roughly rubbed into the bare skin daily will in the average person produce definite symptoms of mercurial poisoning. The reason why a comparatively small dose frequently repeated will produce marked symptoms of poisoning is that while mercury is eliminated through every secretion of the body such as sweat, the urine, fæces, tears and saliva in about 24 hours, a certain residue remains, and, if you persist in the small dose what is known as cumulative action takes place. That is the first thing to remember. The second thing to remember is that practically the same amount of mercury in the form of calomel volatilised and inhaled is required to produce poisoning as that of metallic mercury rubbed into the skin. If you have to have 20 grains of mercury rubbed into the skin to produce mercurial symptoms of a certain degree in a certain individual, about 5 grains of calomel volatilised and inhaled —which is physiologically equal to about 20 grains of mercury—will have the same effect. Only a slightly larger amount is required to produce the same effect, if it is volatilised, and the fumes are permitted to come in contact with the bare surface of the human body as used to be done and is still done, I believe, in some places for the treatment of syphilis. So, you see, it does not matter whether you inhale a certain amount of mercury or rub it into the skin, the effect is the same. If you consider the ordinary working conditions of a man in an ordinary reduction works, I think you will agree with me his chances of ingesting a given quantity of metallic mercury or rubbing it into his hands are far greater, especially if gross negligence is present than of inhaling an equivalent amount of volatilised mercury. No doubt the thing to go for is the prevention of absorption of mercury through the hands and of actually eating it. 20 grains is not a very great amount, but if persisted in daily and carelessly rubbed into the hands or put into the mouth it will produce mercurial poisoning in the average man. That fact is not apparently appreciated by the body of workers. Hence my reason for pointing out to Sir Evelyn Wallers the undesirability of continually changing men after you have educated them in this matter. If you consider this is of importance, I hope you will take the opportunity of discussing it. I shall be glad to answer any questions members may like to ask.

The President: We are indebted to Dr. Orenstein for his remarks on Mercurial Poisoning.

Mr. J. M. Neill (*Member*): The only question I should like to ask is:—Is it an essential condition in order to get mercury into the skin, that it should be mixed with about 30 per cent. of grease?

Dr. A. J. Orenstein (*Member*): It is not. When mercury is rubbed into the skin in the form of an ointment the absorption into the skin is made easier, because it is subdivided into small particles in the ointment; the grease in the ointment facilitates the entry of the mercury into the pores of the skin. It is undoubtedly possible to rub in the ordinary metallic mercury into the skin; mercury will rub up very fine on the palm of the hand. It will probably take considerably more time to rub, say, 20 grains of mercury into the pores of the hands or into your arms without the aid of grease, than it would if it were previously finely emulsified with grease.

THE IDENTIFICATION OF QUARTZ PARTICLES IN KONIMETER SAMPLES.

By Dr. A. W. Rogers, F.R.S. (*Member*).

The following description of a method of distinguishing particles of quartz from those of other minerals in mine dust has been drawn up from notes of experiments, undertaken at the suggestion of the Government Mining Engineer, on the application of refractive indices to the purpose. The method enables one to count the number of quartz particles half a micron wide or larger, separately from those of other minerals found in dust caught by the konimeter. The counting is done as rapidly as that of dust particles themselves.

When the contact between a colourless mineral and the surrounding medium is examined under a high power of the microscope, it is more or less clearly visible according to the difference between the refractive indices of the two substances. If the tube of the microscope be raised slightly above the position of correct focus, the side of the contact occupied by the substance with the higher index becomes strongly illuminated, while the other side is darker than the rest of the field of view. When the tube is lowered, the bright light goes to the side occupied by the substance with the lower index. This method of comparing refractive indices is known as the "white line," or Becke's test, and it is commonly used in petrography, where the size of the grains is usually much greater than that of dust particles. The effect produced is considerably more conspicuous in a dust particle than in the minerals of a thin section of rock, because the particle is small, and the "white line" becomes a spot of light when seen within the area of the particle, and also because the contact between the dust and medium is free from a third substance, which is often not the case with minerals in rock slices.

The phenomena are easily seen in white light when the difference between the indices is 0·002; so that when two minerals differ by 0·004 or more, their immersion in a liquid with refractive index about half way between those of the minerals enables one to count the particles in two classes, those which appear as bright spots with raised tube and those which appear as bright spots with lowered tube, respectively more and less refractive than the liquid.

The minerals which make up the sedimentary rocks of the Main Reef horizon are known through microscopic examination of thin sections; of the transparent constituents quartz is the most abundant, then come the flaky minerals mica, chlorite and talc, and the less abundant or occasional minerals are chloritoid, calcite, zircon and a few others less often seen. Of all these minerals quartz has the lowest mean refractive index; the lowest indices of talc and calcite are lower than the least index of quartz, but the fact does not affect the observations, because the lowest indices of calcite and talc practically never come into play under the conditions of the test, and if they do their effect is masked by that of their higher indices which greatly exceed the highest of quartz.

The refractive indices of the more common minerals in the rocks of the Main Reef horizon are given in the following table; other occasional constituents such as anatase, tourmaline, epidote, all have high indices:—

		ω	ϵ	
Quartz	... ...	1·544	1·553	
Calcite	... ...	1·658	1·468	
Zircon	... ...	1·931	1·993	
Rutile	... ...	2·616	2·903	
		σ	β	γ
Mica	... ...	1·563	1·598	1·601
Talc	... ...	1·539	1·589	1·589
Chlorite	... ...	1·582	1·584	1·59
Chloritoid	... ...	—	1·74	—

Owing to the fact that the lowest indices of mica and talc have effect only when these minerals are seen edgeway to the cleavage, which, on account of their perfect cleavage, is very rarely the case when the flakes lie in liquid between slide and cover slip, the smallest difference between indices operative in the dust from the sedimentary rocks of the Witwatersrand mines is 0·034, that between the highest of quartz and the mean and highest of talc. Cleavage fragments of calcite have a lowest index of about 1·56, but its effect is entirely overshadowed by that of the highest index of calcite, which every grain of the mineral must show.

In the konimeter the dust is caught on vaseline, and the immersion liquid must be a solvent of vaseline; monobromobenzene, with an index of 1·56, and bromoform (1·58) dissolve vaseline, and a mixture of equal volumes of the two has a suitable index for separating the particles of quartz from those of other minerals in the dust; solution of the vaseline film by it does not lower its index too much.

The position of the spot on the slide removed from the konimeter should be marked by a ring of ink on the back of the slide; a drop of the liquid is placed on a thin cover slip, which is carefully lowered on to the slide, when the liquid spreads over the spot.

For the microscopic examination an eighth-inch objective and low power eyepiece are a good combination, and they resolve particles down to 0·3 micron wide. A twelfth-inch oil immersion objective will extend the resolvability to 0·2 micron, but the smaller field and additional manipulation counterbalance this advantage over the dry eighth. The observations are best made in parallel light, but should the illumination be insufficient, a convergent cone of low angle will serve.

Having got the dust spot into focus and sufficiently illuminated, the tube of the microscope is raised slightly, when the particles with indices greater than that of the liquid (all transparent minerals other than quartz in the dust from the sedimentary rocks from the mines here) appear bright and can be counted. The tube is then lowered below the focal position, when the previously bright particles become dark and are surrounded by a halo of light, while the less refractive particles (quartz) become bright spots and can be counted. It is easier to count bright spots than dark ones, so it is better to count bright spots first with raised tube and then with lowered tube than to count both bright and dark spots with the tube in one position; but the result of both procedures is the same. Opaque particles are counted with the tube in the focal position. Particles which are below the limit of resolution appear as indefinite spots by diffraction, and they may be confused with either class, for they give light spots with raised or lowered tube, but very little experience is required to recognize them and avoid any error from their presence. Neither the shape nor transparency of these particles can be determined and one remains in ignorance of their nature.

The following figures were got from dust collected by a Kotze konimeter:—

n less than 1·57.	n greater than 1·57.	opaque.	Total counted
86	14	(not counted)	330
59	11	30	380
46	5	49	295
60	9	31	813
56	11	33	141
63	7	30	931
50	10	40	223
45	14	41	492
77	4	19	447
44	20	36	293
50	13	37	145
51	10	39	360

The particles with indices less than 1·57 are without doubt quartz, for the dust came from quartzite and conglomerate of the Main Reef group. Many of the opaque particles are pyrite, as shown by the colour of the larger ones when examined in reflected light.

If felspars occur in the rock which furnishes the dust, as they do in some of the intrusive rocks in this district, their particles would be counted as quartz by the method described above. In most of the dykes of the Witwatersrand, however, the felspars have been replaced by quartz, mica and epidote, which cause no difficulty; but if kaolin be present it would behave like quartz. The other minerals in the dykes are chiefly amphiboles and pyroxenes, which are much more refractive than quartz.

In dust from rocks containing the oligoclase andesine and labradorite series of felspars as well as quartz, it is practically impossible to count the felspar particles separately from those of quartz on a large scale; but the alkali felspars, orthoclase microcline and albite, can readily be counted separately from quartz in dust from granite by the use of monobromobenzene or bromoform diluted with xylol or benzene, and all these minerals separately from more refractive ones by the mixture used on the dust from the local mines. Owing to the widely differing boiling points of the two groups of liquids, the refractive index of the solution becomes higher by evaporation of xylol or benzene, and this must be guarded against.

The method described here is capable of great refinement by the comparison of the lowest and highest indices of individual grains in polarized light, by which the effect of each index can be isolated and eliminated in turn; though this can be done quickly, its application to the hundreds of particles in one dust spot would be tedious, and the observer must have a knowledge of mineral optics as well as experience in microscope work in order to get good results. It is clear that the mineral composition of the rocks in the Witwatersrand mines is very favourable for counting the quartz particles in the dust, because the refractive indices concerned are very conveniently distributed. On this account an exact knowledge of the index of the immersion liquid is not wanted; it can be estimated closely enough by observation of powdered quartz and mica.

The application of the method to dust of less convenient composition, *i.e.*, dust made of minerals with overlapping indices, would require accurate knowledge of the index of the liquids used, and the solution of vaseline would have to be avoided.

Footnote.—Much information bearing on the method described above will be found in the following books:—

Wright, The Methods of Petrographic-Microscopic Research, 1911.

Grabham, in Mineralogical Magazine, vol. XV., 1910, p. 341.

Johannsen, Manual of Petrographic Methods, 1914.

Schroeder van der Kolk, Tabellen zur Bestimmung der Mineralien nach ihrem Brechungsindex, 1906. (Schroeder van der Kolk's method is a different one from that described above, and it is not applicable to particles as small as those of mine dust, but the book has useful tables of indices.)

Rosenbusch - Wulfing, Mikroskopische Physiographie der petrographisch wichtigen Mineralien, 1905.

Iddings, Rock Minerals, 1911.

The two last mentioned books contain very convenient tables of refractive indices.

Mr. C. J. Gray (*Member of Council*): I believe one of the commonest criticisms of the Konimeter is based on the difficulty of making certain that all the dust particles shown under the microscope are quartz dust and therefore injurious. I think too much importance has been given to that criticism, and that the number of dubious particles is not great in comparison with those which are undoubtedly quartz, but still there is the difficulty, that it can be alleged at any time that the dust counted is not really quartz dust. The work done by Dr. Rogers, and of which he has given us the result, will remove that difficulty to a great extent as if doubt is raised in any particular case, the dust spot can be examined by his method. I propose that a hearty vote of thanks be accorded Dr. Rogers for his paper.

Sir Robert Kotze (*Member*): I would like to point out the advantages of this method as against the method usually in vogue in ascertaining the nature of mine dust. The only other method by which the nature of the dust can be determined is to have a sugar-tube sample taken and to make a chemical analysis. The collection of a sugar-tube sample which will contain enough dust to enable a chemist to perform his operations on it takes a very long time. The Miners' Phthisis Prevention Committee on one occasion took a fortnight to collect such a sample. Well, that is a very long time to collect a sample, but that is not all. The work involved after you have collected your sample is also very tedious; the chemical analysis of silicious dust is fairly complicated and takes time to complete, and when you have got it, it only gives you the chemical constituents, not the mineral constituents. You are able to infer fairly closely what the amount of free silica would be, but not absolutely accurately. If you compare the whole process therefore with this other method of Dr. Rogers, in which the taking of sample is more or less instantanous and the subsequent examination may take an hour or two, the total time spent on it and the labour involved are as nothing compared with the older method. Personally I owe a debt of gratitude to Dr. Rogers for making this investigation and getting so neat a solution of the problem. I started the idea in the hope that it would be possible to get such a solution, but the lines on which I proceeded, and which had some similarity to the method of Dr. Rogers, would not I think have yielded the desired result. This is a good example of the advantage of not relying entirely on one's own resources but of calling in the assistance of experts. One might have thought it rather far-fetched to call in a geologist to advise on the question of dust determination. Well, as a matter of fact, I went to the right man by referring to Dr. Rogers. He gave me the solution in a very short time. I may say, as far as the method itself is concerned, I do not think it is a difficult one. I do not pretend to be an expert petrologist or microscopist. The first time I tried the method I was not successful, but I succeeded easily at the second attempt. Although the mixture of liquids used gets discoloured and turns brown on standing in the light, this does not seem to matter much. I had some of the liquid at my house and kept it for about a month. It was then quite dark brown. On trying it to-day, although I did not expect it, I found it still quite effective. Of course the liquid is now yellowish in a thin film, but the optical effect described by Dr. Rogers was still quite easily seen. I have great pleasure in seconding the vote of thanks.

Mr. A. J. R. Atkin (*Visitor*): I am sorry I am not able to contribute in detail to Dr. Rogers' paper to-night. I have used the method quite successfully, and find it quite easy of application. I hope at the next meeting to contribute a few remarks, which may be of interest. In the meantime, if any member of the Society would like to see the method I am prepared to demonstrate it almost any afternoon if given a little notice.

NOTES ON ROUTINE ASSAYING AT THE GLOBE & PHŒNIX MINE, SOUTHERN RHODESIA.

By Mr. H. R. Edmands.

As some innovations in assay practice have been made here, a short description of the methods adopted may be of interest.

The ore itself presents no particular difficulties; it contains stibnite, averaging perhaps 2%, and although much of the gold is fairly fine, coarse gold is also frequently present. Some 1,600 to 1,800 assays are made per month, and a day's run seldom much exceeds 100.

Preparation of samples.—In dealing with the samples received the chief difficulties in getting representative portions for assay are as under:—

Crushing mine samples before quartering.—Just how far crushing should be carried depends, of course, on the even distribution, or otherwise, of the gold in the ore. Bearing in mind that a piece of ore 1″ cube on being reduced to 1/8″ cubes would be divided into 512 fragments, as against only 64 if reduced to ¼″ cubes, the importance of fine crushing at this stage is evident. Coarse rolls following a breaker would in many cases be advisable.

Segregation of values in fine crushing and screening.—The more brittle or softer portions of the ore, being the first to be crushed, will be separated from the harder portions (carrying different values) by screening during crushing. A similar segregation occurs with disc pulverizers, and very thorough mixing of the ground product is required to get accurate results.

Coarse gold will obviously cause discrepancies in duplicate assays. Some consideration of the law of averages affecting this is not without interest.

Assuming that 20 dwt. ore is dealt with, that 2 assay tons are taken, and that the gold and quartz exist in spheres of equal size, then if Poisson's law be applied it will be seen that if these spheres be 1/60″ diameter, the maximum error will be 39 dwt., and the mean error 9·2 dwt.

If spheres be 1/100″ diameter, the maximum and mean errors will be 16 dwt. and 4·5 dwt.; if 1/200″ the errors will be 5·6 and 1·6 dwt., while 1/400″ spheres would give maximum and mean errors of 2 dwt. and 0·56 dwt. respectively.

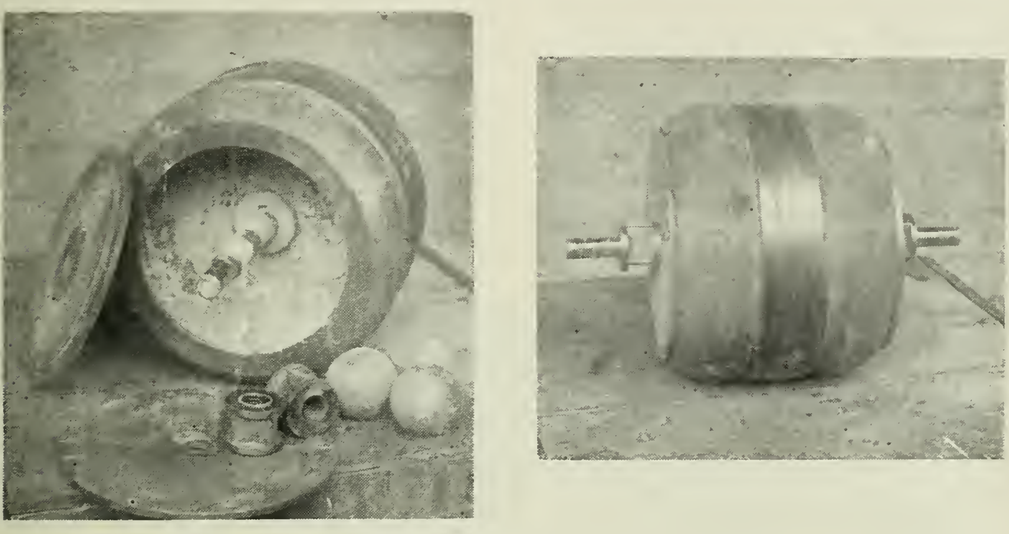
Doubling the amount taken for assay does not halve the error, which varies inversely as the square root of the weight of sample taken.

Although on crushing a sample to pass, say, a 60 mesh screen, the greater portion of the gold would be very much smaller, yet if the crushing is effected with frequent screening or by means of a disc pulveriser, which acts much as does a screen, the gold will not be so finely divided as it would be if the sample were crushed, say, in a ball mill without removing any portion until the whole had attained the required degree of fineness. In the latter case attrition of gold continues throughout the grinding, in the former, some of the coarser gold is removed, when it will just pass the screen or escape between the plates of the pulverizer.

More concordant results would be expected from crushing in ball mills, and this is borne out by practice.

Ball mills for sample grinding.—To eliminate as far as possible some of the sources of error alluded to, I designed a mill capable of taking the product of the breaker and reducing it at one operation to practically any degree of fineness required, this being regulated by the time of grinding and the weight of balls used.

As will be seen in the accompanying photographs, the mill is divided into two compartments, each taking a separate sample of about 600 or 800 gm. Its inside diameter is 11″, each compartment being 3 5/8″ wide. Two 3″ balls are used in each compartment. The mill is driven at 70 R.P.M. by $1\frac{1}{2}$″ belting, direct from 2″ countershaft, without pulleys, and the belt runs over the centre of the mill, which is slightly crowned. (See plates.)



Ball Mills for Sample Grinding.

Excluding the cost of the pattern, the mills were made, on the mine, for a little under £5 each.

A timber frame of simple construction holds the mills, the bearings are of native hardwood, open at the top, so that the mills can be lifted in and out by two hooks. Each compartment of the mill is opened by one nut, and its contents emptied into a pan. It is then cleaned by compressed air. Eight such mills, taking 16 samples, are in use.

The mills are cheap, readily accessible for cleaning, and wear is inconsiderable, very much less than with disc pulverizers; also as the wear is even, it does not affect the efficiency of the mill, which is not the case with disc pulverizers.

The final product is perfectly mixed, and, no screening being required, is ready for assay.

A 600 or 700 gm. sample that just passes a 3/8″ mesh will, after $1\frac{3}{4}$ hours' grinding, give a product averaging—

	+ 60	Nil.
− 60	+ 100	0·5
− 100	+ 150	6·0
− 150		93·5

A reduction of native labour has been made since they have been used. Assays have checked better, and, although they are slower than disc pulverizers, their advantages outweigh this drawback, at least with this ore.

Battery discharge (screen) samples.—Lime is added to promote settlement, the clear water decanted, and the thick pulp well mixed. The portion taken for assay has most of its remaining water removed by an air pressure filter (see plates), after which it can be quickly dried. This type of filter is quicker than, and preferable to, a vacuum filter, except when the cake requires washing, for which it is unsuitable, cracks being apt to form and cause channelling. The dried sample is ground for 2 hours in the ball mill, when all passes a 100 mesh sieve, and 98% passes a 150 mesh sieve. Fine grinding is essential to get concordant results.

Reduction Samples.—These do not require fine grinding, all but the finest gold having been removed by amalgamation.

Reduction samples, containing dissolved gold, are treated as follows:—The dissolved gold is precipitated, usually by adding cuprous chloride dissolved in brine, to the pulp, and acidifying with sulphuric acid. The pulp is then filtered in the air pressure filter and dried. This is not only much quicker than drying without filtration, but gives more accurate results. If the excess of barren solution be not removed by filtration, some of the gold is apt to re-dissolve on heating, and to form an enriched hard scale adhering firmly to the dish. In the case of richer solutions I have found the error, presumably from this cause, to be quite considerable. In cases where much sulphocyanide is present, and precipitation by a cuprous salt is imperfect, an emulsion of finely ground charcoal should be substituted, or used in conjunction with the cuprous salt, when perfect precipitation is obtained.

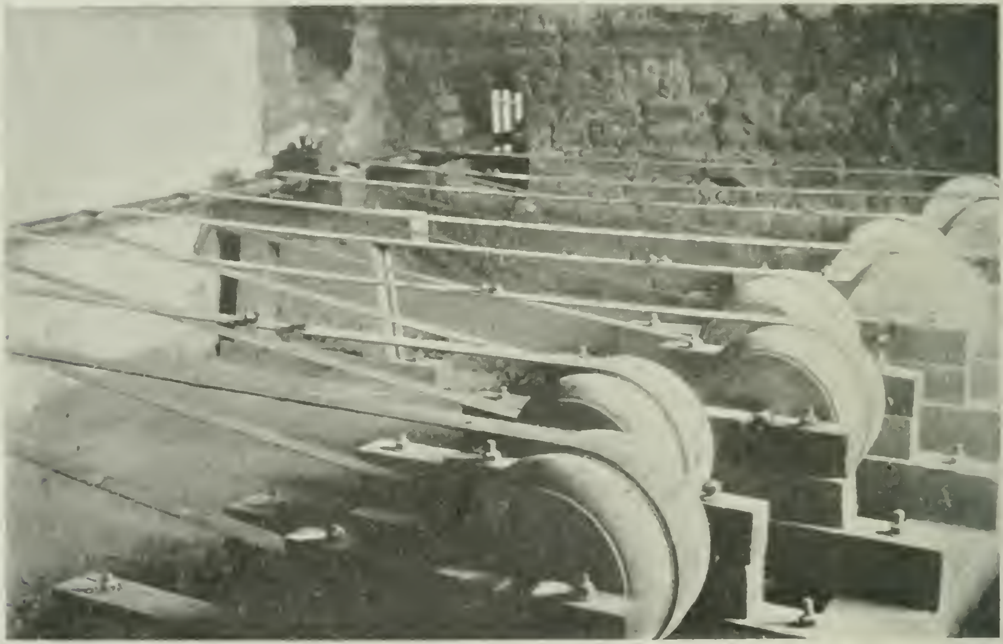
Fluxing.—The substitution of fluor spar for borax, both wholly and in part has been tried, but with unsatisfactory results.

Mixing ore and flux.—This is effected by shaking in a large glass with a metal cover, to which is cemented soft sheet rubber. Mixing is more thorough and quicker than by the older method of rolling on glazed paper.

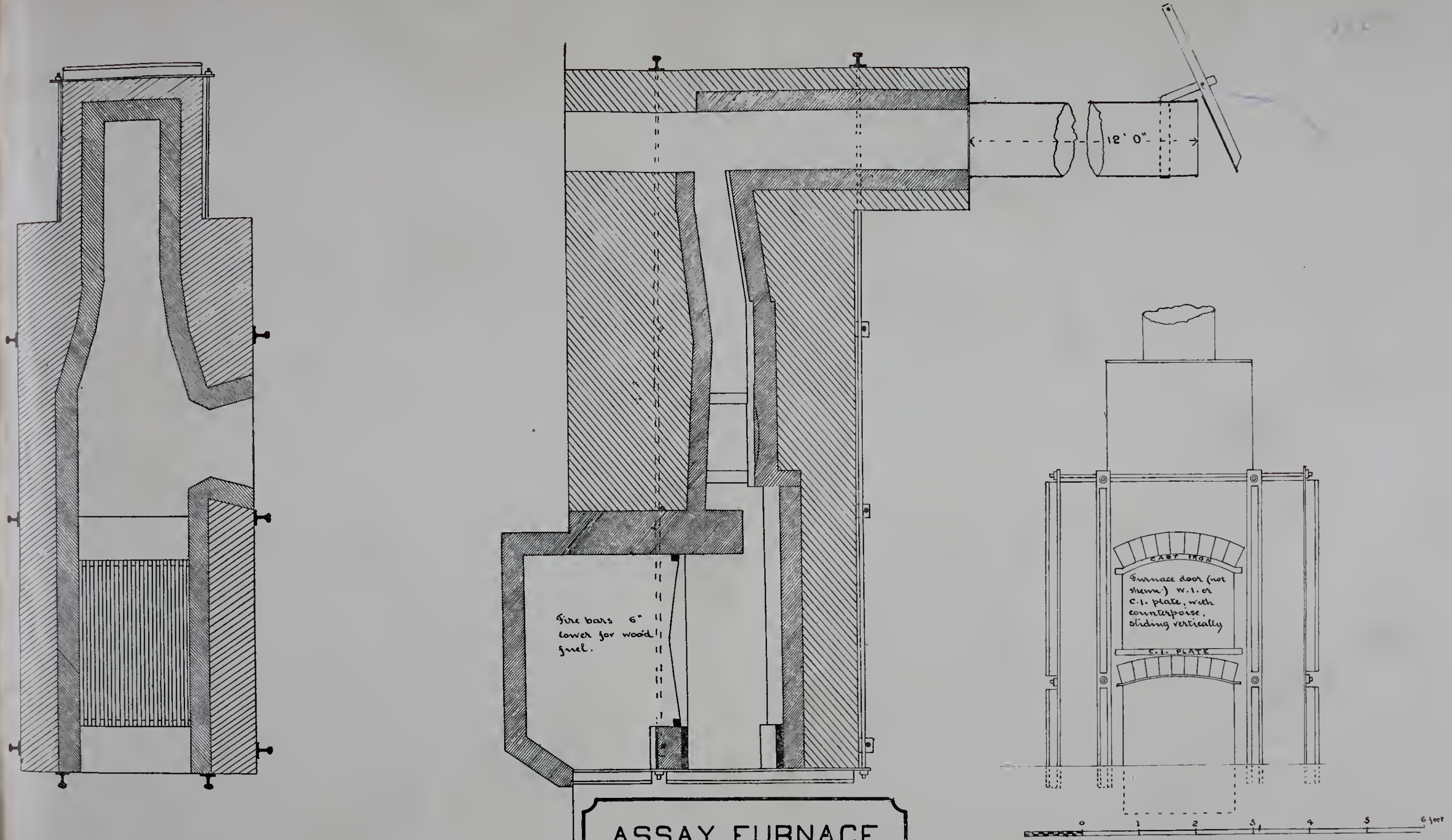
Assay furnace.—The coke-fired Cornish furnaces, formerly in use, have been replaced by a reverberatory furnace shown in the diagram.

This type of furnace I previously adopted in Western Australia for burning wood, and it follows, I believe, the general lines of those used on the Rand. Both wood, wood and coal, and coal alone have been used, the first being much cheaper in Western Australia, and the last somewhat cheaper here.

Special features are—(a) the abrupt lowering of the top arch just behind the firebridge, deflecting the flame on to the front row of pots. (b) The hearth is not level, but rises gently from bridge to flue, obviating the danger of pots falling backwards. (c) The hearth is covered with a layer of sand, or, preferably, of sifted earth, which absorbs any slag spilled. (d) The



Ball Mills for Sample Grinding.


12' 0"
Fire bars 6" lower for wood fuel.
CAST IRON
Furnace door (not shewn) W.I. or C.I. plate, with counterpoise, sliding vertically
C.I. PLATE
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3
4
5
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ASSAY FURNACE

H. R. Edmands

(*Facing page 182.*)

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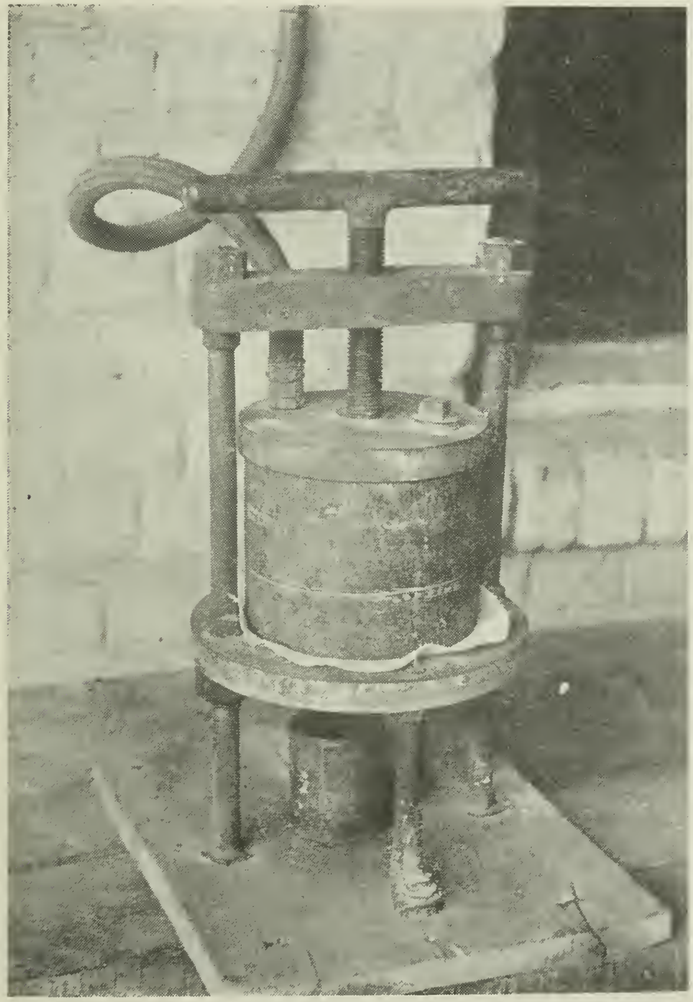
furnace has an independent stack with a damper at the top capable of very close regulation; the earlier type of furnaces had dampers at the base of stack, and were burned out quickly.

The furnace will take a charge of about 56 pots, usually 6 or 8 J's, and the remainer G's and Fs; the heat is very uniform, and the pots last considerably longer than with Cornish furnaces. During fusion the damper is nearly closed, and a somewhat reducing atmosphere is maintained.



1. Air Pressure Filter.

Two charges of pots generally complete the day's work, after which the same furnace, without a muffle, is used for cupellation.

Cupellation is effected as follows:—Bricks are placed on the hearth of the furnace to support wrought iron plates, each carrying about 25 cupels. The cupels are charged with lead buttons while they are cold. A good fire is made, and the damper opened rather more than when the pots are in. The atmosphere is reducing at first, but soon becomes oxidising and cupellation proceeds steadily. Many checks have been made by re-cupelling prills of parted gold, but no loss of weight could be detected.

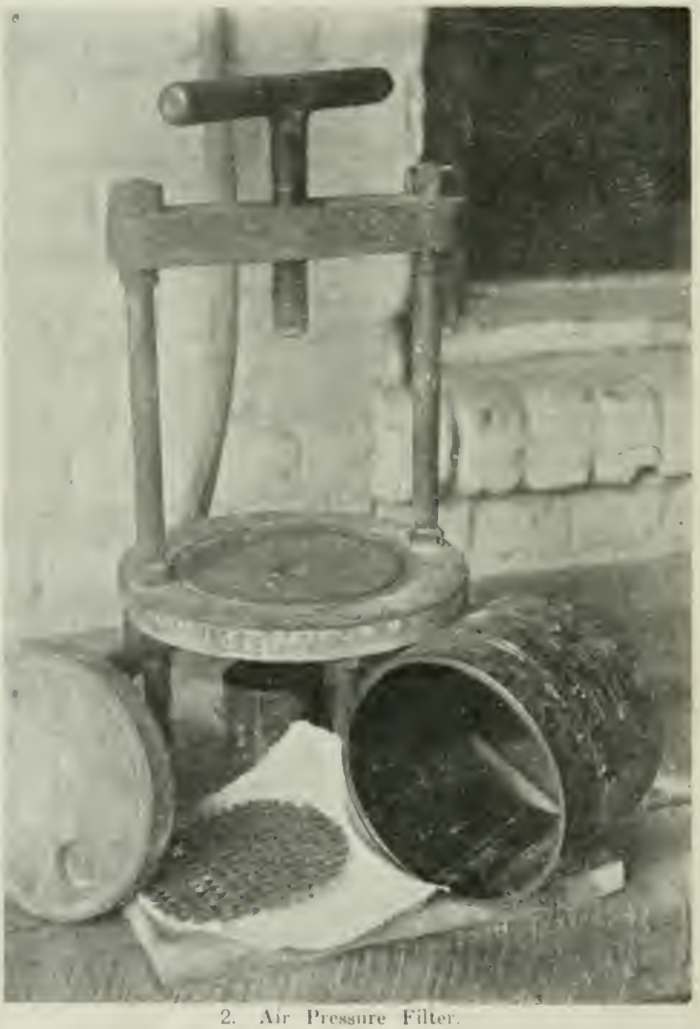
Sir T. Kirke Rose has lately shown (Inst. M. & M. Bull. 174, March 13, 1919) that gold is not readliy volatilized either in a reducing or an oxidising atmosphere, but that losses are much greater when exposed to alternate reducing and oxidising conditions. Such conditions occur here, but at an early stage when the gold is well protected by lead, which probably acounts for the absence of appreciable gold losses.

Over 100 cupels can be taken in one charge, and so far as I know, this system of cupelling without a muffle is unique in assaying It, however, should be noted that all assays here are parted; whether it would answer as well in cases where the gold prills are weighed direct I cannot say from experience.

Cupels.—For the past 12 months these have been made from old used cupels, reground in a ball mill. The absorbent power of these cupels is excellent, and they are in every way satisfactory.

Cement, and mixtures of cement and mabor were previously tried, but were not altogether satisfactory. A very excellent cupel can, however, be made from a mixture of mabor and bone ash.

Parting.—Perforated sheet iron trays, each carrying 24 parting cups, and fitting over an electric hot plate are used.



2. Air Pressure Filter.

Failing an electric hot plate parting can be done over the hot cupels, covering the latter with a sheet of 1/8″ copper to more evenly distribute the heat. Waste acid, after precipitation of silver, is sent to the smelting house and used in cleansing bullion. The recovered silver is made into silver nitrate.

Annealing.—The tray of parting cups is allowed to rest a few seconds on a red hot cast iron plate of the same diameter as the hot plate

Solution assays.—Precipitation by a cuprous salt has hitherto been the practice here and correct results are obtained on fairly clean solutions. Instead of adding cupric sulphate, sodium sulphite and hydrochloric acid, better results were obtained by adding cuprous chloride dissolved in brine and acidifying with sulphuric acid. The cuprous chloride solution is made by dissolving 3 parts cryst. cupric sulphate in 20 parts saturated salt solution, and reducing to the cuprous state by metallic copper. 15 cc. of this solution, which should be colourless, suffices for 20 A.T. solution to be assayed. Sulphuric acid must be used for acidifying, as hydrochloric acid gives low results. I prefer to scorify the precipitate after drying, with a mixture of 2 parts of litharge to 1 part borax, with enough flour to give a suitable button. Scorification is readily effected on the hearth of the reverberatory, and appears to be better than a pot fusion.

Although this method is suitable for clean solutions, all copper methods give low results in presence of much impurity, especially of sulphocyanides. Ferrocyanides also interfere, but to a less degree.

The zinc and lead acetate method is much less sensitive to the more commonly found impurities, but was not used here owing to the impossibility of getting a clean lead sponge.

A modification of this method has, however, lately been adopted, in which the assay is made without heating the solution.

As filtration and fusion of the precipitate previous to cupellation are in any case necessary here, and as precipitation is complete in the cold, much time and some expense are saved by the omission of heating. The procedure is as follows:—To 20 A.T. of solution add 5 gm. zinc dust with vigorous stirring, then enough silver nitrate to ensure parting, and 40 cc. of 20% lead acetate solution, again with thorough stirring. Finally add 30 cc. hydrochloric acid cautiously, and stir until all action ceases. Filter and scorify with the same flux as used for the copper method, but with the addition of powdered glass. Nearly all the zinc is eliminated by the acid, and the remainder by scorification.

Scorification is often troublesome in a muffle, where the space is limited, but this does not apply to the hearth of a reverberatory.

This method gives accurate results on all but the most impure solutions.

Reduced costs.—Since the use, early in 1919, of a reverberatory furnace, ball mills, air pressure filter, etc., the total cost of assaying showed a considerable decrease from the previous year, although more assays were made, wages and supplies rose, and the cost of new plant was included.

Note 1. Poisson's Law.—Beringer, in the appendix to his Assaying, treats this rather fully. It may be formulated for the present purpose thus:—Let x equal the number of gold spheres, y the quartz spheres, and z the combined number of gold and quartz spheres; then—

$\sqrt{\frac{8\,xy}{z}}$ equals limit of deviation by error in number of gold spheres present. To find the mean error the result so obtained has been multiplied by 0·2786.

In the applications given I have calculated the number of spheres of gold and quartz in a 2 A.T. sample, assaying 20 dwt. gold.

Note 2. Solution Assays.—A good deal of work has been done on this subject, to detail which would occupy too much space. It was clearly shown that considerable losses occurred in assaying impure solutions by the copper method, and that most of the loss can be recovered by assaying the filtrate by the zinc dust method. Also pure solutions were prepared, to which definite quantities of impurities were added, and their effect in lowering assay results noted.

Mr. John Watson (*Member*): I have much pleasure in proposing a vote of thanks to the author of this paper. As it has only come into my hands to-night, I have not had much time to study it. There is, I see, this special feature about the ore in that it contained about 2% stibnite. Another feature is cupellation without the use of a muffle, which, as the author says, is unique. The author of this paper has had Western Australian practice, which, of course, is somewhat different from that in vogue on the Rand. The type of reverbatory furnace previously adopted in Australia was for burnt wood, whereas here we can use coal. It is always interesting to learn of the practice on other mines and districts.

"GOLD ZINC CYANIDE."

By Mr. W. R. Feldtmann (*Past President*).

REPLY TO DISCUSSION.

(*Printed in Journal, August, 1919.*)

My short paper on this compound insomuch as it was merely a statement of facts with only a very tentative excursion into the region of conjecture, could hardly be expected to call forth much discussion. For the kindly comments of the President, of Dr. Caldecott and of Dr. Moir I wish to express my thanks.

Judging by the reference in Coney's Dictionary, to which Dr. Caldecott calls attention, gold-zinc-cyanide has evidently been noticed before, although I have found no record of it in recent text books, such as Roscoe and Scherlemmer's new edition, nor in "The Chemistry of the Cyanogen Compounds," by H. E. Williams (1915). I venture to hope, therefore, that most of the particulars I have been able to give are new to the members and that the occurrence of the compound in isomeric forms is of particular interest.

Dr. Caldecott appears to have formed the impression that I found the gold-zinc-cyanide in a zinc-gold slime such as is formed in cyanide plant precipitation boxes. This, of course, is not the case, as the compound could not exist in presence of alkali in working cyanide solutions. Actually I first noticed it in a beaker into which I had emptied gold-cyanide solutions left over from laboratory experiments. These solutions contained a trace of zinc, and, on being acidified to precipitate AuCy, they deposited, after some hours, minute quantities of the prismatic crystals of gold-zinc-cyanide mixed with the AuCy.

I could wish that Dr. Moir had carried his interesting remarks a stage further, when dealing with the conjectural part of the paper. If he is right, as may well be, in assuming that there should be no difference between gold-zinc and zinc-gold cyanides, it will be necessary to find another explanation for the occurrence of two distinct forms of the compound—one prismatic and the other pyramidal; one formed from $KAuCy_2$ and the other from $HAuCy_2$. It is just possible that the pyramidal form is a polymer, as the conditions under which it is produced are such as tend to polymerize HCy, for instance. But, until further evidence is available, Au_2ZnCy_4 and $ZnAu_2Cy_4$ respectively may serve to indicate a difference in molecular structure in the two forms in question.

HANGING WALL SUPPORT IN THE FAR EAST RAND.

By L. W. Macer (*Associate*).

REPLY TO DISCUSSION.

(*Printed in Journal, November, 1919*).

The paper has provoked very little discussion. I am therefore all the more grateful to those members who have participated therein.

In reply to Mr. Chilton I cannot quite agree with the wholesale condemnation of the pillar. If of adequate dimensions and systematically placed, as in the "Panel System" to which I have referred, I consider the pillar to be not only justifiable, but perhaps the only sufficiently rigid support for use in deep mines.

As to pillars of inadequate dimensions unsystematically placed, I am fully aware of their uselessness, or, even their danger, as permanent supports.

Mr. C. J. Gray agrees with my condemnation of the yielding support in deep level mining, but is apparently, like myself, at a loss to suggest any really rigid contrivance which is suited to stoping conditions. The use of concrete, in any form, I find to be unsatisfactory and entirely unsuited to the conditions in stopes.

"A GENERAL REVIEW OF THE ECONOMIC RESULTS ATTENDING THE GOLD AND BASE METAL MINING IN THE PRETORIA INSPECTORATE DURING THE PERIOD 1904 TO 1914."

By Tudor G. Trevor, A.R.S.M. (*Member of Council*).

(*Printed in Journal, October, 1919*).

DISCUSSION.

D. W. Rossiter (*Associate*): We are all indebted to the author for his having drawn attention to the fact that "there is a large and growing section of the community who appear to believe that the low grade mines exist purely for the benefit of the promoters and that therefore, there is no reason why they should be encouraged by the State or why they should not be taxed to the breaking point." It is probably not realised fully to what extent Johannesburg and the towns along the Reef, and indeed the whole of South Africa generally, and the Union Government is particular, depend upon the low-grade gold mines.

In December last, before effect was given in the various gold mining companies monthly accounts to the gold premium obtained, there were 28 companies working at a loss or making only a trifling profit. In March, 1920, when effect had been given in the monthly costs to the increased pay to Whites (agreed to between the Chamber of Mines and Labour Unions), these 28 companies were crushing at the rate of 14,005,488 tons per annum with working costs absorbing £18,362,544.

This working costs figure can be apportioned approximately as under:—

White Wages	32%=	£5,876,014
Native Wages	19%=	3,488,883
Total Wages Bill ...	51%=	9,364,897
Stores	40%=	7,345,018
Sundries	9%=	1,652,629
	100%=	£18,362,544

It has been estimated by competent authorities that of working costs at least 70% is retained in this country; therefore in the case of the 28 companies in question this would represent over £12,850,000 per annum.

From figures which were got out in respect of a gold mining company with which the writer is connected, it would appear that the revenue (excluding profit and dividend taxation) which accrues to the Government on account of railage, wharfage, Customs duties, claim licences, railway fares for natives, postages, telegrams, etc., etc., is approximately 1s. 10d. per ton crushed, equal on 14,005,488 tons to £1,283,836. This, of course, is by no means all that the Government would get, because obviously on the wages paid to mine employees, and on the revenue received by merchants, shopkeepers, and others, there would accrue to the Government various amounts by way of Customs dues, Income Tax, etc., etc.

As to stores consumed on the gold mines the expenditure under that head is estimated as shown above as being 40% of the total working costs or say £7,345,000 per annum, in respect of the 28 companies above-mentioned. From analysed figures in the writer's possession it would appear that

The estimated f.o.b. (overseas ports) cost of imported stores is	35%=	£2,570,750
Shipping, freight, insurance, commission and exchange	7%=	514,150
Railage, wharfage, Customs dues, absorbed in South Africa and therefore revenue to Union Government	14½%=	1,065,025
	56½%=	4,149,925
Leaving in hands of South African farmers merchants, manufacturers, etc., etc., etc.	43½%=	3,195,075
	100%=	£7,345,000

As already pointed out, on a portion of this £3,195,075 Income Tax and other revenue would accrue to the Government, whilst the balance would otherwise circulate in South Africa by way of salaries, markets for farm produce and trade, all of which affect the revenue of the country, as well as the thousands of individuals concerned.

The closing down of low grade mines will therefore undoubtedly be a serious matter for this country—far more serious than many people imagine, especially in the absence of other mines or industrial concerns to take their place; and the writer hopes that the foregoing figures will help members and others to realise the acute crisis that faces South Africa in view of the critical position that confronts so many of the low grade gold mines and the probability of many of them having to shut down.

REPLY TO DISCUSSION.

Mr. T. G. Trevor (*Member of Council*): The writer first wishes to thank the members for the extremely friendly spirit in which his paper has been received. The criticisms on the paper have mostly taken the form of augmentation to it, and, therefore, in replying to the discussion, he is in the fortunate position of not having to substantiate any disputed points, but rather of confirming what his commentators have stated and of adding to their commentary.

In the first place, the writer would point out that the figures he gave only referred to metal mining. Diamond and coal mining were purposely and specifically excluded. If the figures for these mines were included, then the direct and indirect revenue to the State would be multiplied several times.

Without going into details, it may be stated that during the period under review—1904 to 1914—the output from the diamond mines in the Inspectorate was valued at £16,672,880, and that from the coal mines at £6,706,234, and the direct revenue from the Government's share in the Premier Mine amounted to no less than £2,659,706.

The arguments brought forward by Messrs. Keay, White and Weston for State aid in prospecting, and embodied in the resolution presented to the Honourable the Minister for Mines and Industries, are therefore, very much stronger than those gentlemen realised.

With regard to the advancement of the country by the discovery of new mineral deposits, the writer himself has frequently represented to his department, and so also have his chiefs and colleagues, what they consider the best method of encouraging such discoveries, but unfortunately the first and most important of these methods—compared to which all the rest are trivial—at once comes into conflict not only with the Gold Law but with the Grond Wet of the land. This refers to the throwing open of the country to prospecting.

Under the Grond Wet, or Constitution of the Transvaal, the title of ownership of ground confers on the owner absolute ownership of all minerals, other than gold or diamonds, and their rights to these even are such that the owners can effectually bar the State taking possession of them if the owners themselves do not wish them worked.

It is, of course, out of place here to enter into a general description of the titles under which farms are held in the various States of the Union, but, with the exception of certain farms in Natal and certain others in the Transvaal recently allotted, but which remain open to prospecting, no prospecting is legal on any farm without the consent of the owner. That consent has to be bought with money, which money has in practice to take the form of option money, paid for the option to buy the farm at a fancy price within a specified time if prospecting operations are successful.

Stated briefly, the landowner is in the position to charge the prospector a cash sum down for the right to attempt to prove the land valuable; over and above that cash premium, to charge him what he likes for the purchase of the ground after he has proved its value. This is obviously such bad business for the prospector that it is really wonderful that anyone has ever been found to accept the position and that any prospecting at all has been done on private farms. Of course, no one can blame the farmer for taking full advantage of the position, but it is submitted that the position is detrimental to the public interests and indirectly to the interests of the landowning class as a whole, and that those interests would be very much better served if the present owner's mineral rights were compounded for a definite interest in all the minerals won from the farm and that free prospecting were allowed.

In the case of base metals, when the prospector or option holder has found these, the position is simple, and he can proceed to mine them without further legal difficulties. In the case of precious metals or stones, however, his legal difficulties now begin. Theoretically, under the Gold and Diamond Laws, it is illegal to produce any precious metals or stones except from proclaimed ground, and, however much the Mines Department may ameliorate this by allowing trial crushings, etc., sooner or later the ground has to be proclaimed.

To compensate the owner for his loss by disturbance, and in payment of his share of the mineral rights for precious metals, he is allowed to beacon off one-fifth of the area to be proclaimed as his personal mynpacht, but he has to pay for the survey of this and it is subject to a rental of 10s. per morgen per annum. Where a rich gold field of considerable extent is discovered this pays the owner very well, but, in the case where only one or two small deposits of a payable mineral occur on the farm, it is a most clumsy and inequitable provision; for, either the owner is lucky and covers the whole mineral deposit with his mynpacht, leaving nothing for the public, or he is unlucky and spends not less than £100 in survey fees in securing a mynpacht, which proves absolutely valueless.

In practice owners invariably object to proclamation, and, by one subterfuge or another, postpone it as long as they possibly can. It is seldom possible for the Mines Department to proclaim a farm till several years have elapsed after the original discovery.

It is believed by the writer that the above position would be very much improved if the owner had the option to take a royalty of say five per cent. or any other equitable proportion of the gross value, of all minerals produced and sold from the proclaimed area instead of his mynpacht. For, in this case, he would have nothing to lose by the proclamation of his farm except the disturbance caused by prospectors, and whatever happened he would be certain of getting his fair share of the profits derived from the farm.

The matter, however, is a very much larger one than it appears, for it is really but little use proclaiming or throwing open to prospecting individual farms.

As every prospector or geologist knows, minerals are not bounded by the boundaries of a farm—what a prospector needs are whole mineral provinces to work over, following indications from one farm to another until he arrives at the point where these indications are strongest, and where he can do his prospecting work to the very best advantage. A very good example of this is the mineral province represented by the Transvaal Bushveld If the whole of this area were open the writer would strongly advise any prospector, or any house interested in prospecting, to systematically prospect the area, but, as things stand, he does not know of a single farm not yet taken up, which he could definitely recommend anyone to spend money on under existing conditions.

The same is true as to other granite areas. A line of these stretches almost continuously round the sub-continent from Cape Town to Swaziland and eventually to Rhodesia. Near Cape Town and in Swaziland the occurrence of tin in this granite was accidentally discovered and at both places it has been worked, though only successfully in Swaziland. It is probable that tin occurs in many other places along the line. If the land were open to prospecting it would be worth while systematically exploring it for such an occurrence, but, as it is, it would be folly for any man to take up an option on a farm on the chance of that farm containing tin.

Where minerals belong to the owner, as is the case in the original titles, it is to the owner's advantage to have them discovered, and, even though many of the present owners may not appreciate this, their successors undoubtedly will. It is now the custom, however, in granting title to newly alienated Crown Lands, to reserve the mineral rights to the State. In this case the surface owner has no interest whatever in the discovery of minerals; in fact, the discovery of such would distinctly disturb him and be to his immediate detriment; nor is there any machinery provided by the Law by which the Government can prospect for, or work when found, the minerals which it has reserved to itself. A more perfect way of tying up and rendering inaccessible mineral deposits than this it would be hard to find.

It should be within the bounds of human achievement to devise a scheme which should be acceptable to the land-owners, by which prospectors should have access to the whole country; such schemes are in existence in Rhodesia, Australia and many other new countries.

Minerals are now amongst the necessities of life, especially of national life. There are only two basic industries in the world, agriculture (or food winning) and mining. The former provides for our physical existence, the latter provides the materials by which civilisation alone becomes possible. Without these materials we must perforce return to the flint age. The writer would strongly submit that the Society should make this its chief point when addressing the Minister of Mines on the subject of improving the position of prospecting.

With regard to Professor Cellier's suggestions, the writer would point out that in his experience the vast majority of people running small concerns all over the country have no use for the advice of the trained engineer. With the usual confidence of the ignorant man backing his luck, they think no one can teach them anything. Where it is possible to do so, the Inspectors of Mines invariably place their knowledge and experience at the service of these people, and, in some cases, it is made use of with very satisfactory results, but by far the greater number it is repudiated with ill-disguised scorn.

It is extraordinary how little use is made of the Mines Department's offer to do free assays. Far from being bothered by people applying for these the number applied for has been very much less than that which was offered, and where, as is usually the case, the assay does not come up to the expectations of the prospector, the result is invariably put down to the incompetence of the Government Assayer.

There is one line in which, in the opinion of the writer, more can be done for *bona fide* small men, and that is in free reports on the facts connected with a property and in exposing frauds. At the present time a small man in possession of a likely proposition has great difficulty in getting people to attend to him. He cannot afford the report of a reputable engineer, and his own account is usually discounted and discredited. On the other hand, absolute frauds are often advertised and catch the unwary investor. The Government have no means of exposing these, except by a question asked in the House of Assembly about them and by placing the report of the Inspector of Mines on the Table of the House. This, however, is a clumsy method and does not always effect its purpose, for the newspapers do not like taking the risk of publishing a report which, while it is on the Table of the House is privileged, but which may not be so when appearing in their columns.

It has been suggested that an Inspector of Mines, or an officer in a similar position, should be allowed to make short reports on the facts connected with mine properties for their owners. In the case of genuine concerns the owners would ask for such a report and include it in their prospectus—if bogus concerns did not do so prospective shareholders would understand the omission.

In many cases the writer has personally been allowed to give such short reports to claimholders and the result has been most encouraging, for they have often enabled these people to get capitalists to attend to them, who would not otherwise have taken the trouble to listen to the owner's account of the property. The bulletins published by the Department of Mines and Industries have also the same effect, for they give trustworthy and responsible accounts of the mineral deposits dealt with, which are extremely useful to the owners of those deposits.

The writer is greatly pleased with the criticisms of Dr. Stamp on the economic side of the question, as, not being an economist himself, he was very diffident in his conclusions. He is, therefore, glad to find that those conclusions are accepted as correct by Dr. Stamp.. Dr. Caldecott, however, doubts those conclusions.

With regard to the hypothetical case of " A " and " B, " the author did not overlook the fact that in this case there was no usufruct on the transaction, but the loss of interest or usufruct is not loss of capital, and in a great number of commercial transactions there is unfortunately no usufruct.

With regard to the second case quoted by Dr. Caldecott, in a fully developed country, if there is such a thing in the world—which the author doubts—the loss of available labour, when that labour is used for an unproductive purpose, may be a serious item; likewise, the consumption of even one bag of mealies to support unproductive labour might be a serious matter in such a country where every bag is needed for a better purpose. But in a new country like South Africa, where millions of acres are untilled, and where in most districts thousands of natives and many white men are without local employment except in mines and prospecting works, this is not the case; anything that causes production and consumption, and pays for it in a negotiable medium of exchange, is profitable to the State. The only practical loss that occurs in the consumption of imported stores, and the actual consumption of these on small mines certainly does not amount to more than, say, 25% of the total costs. This being so, then the enormous importance of the mining industry to the State, especially to an undeveloped State, is at once apparent —that industry is far more immediately profitable than any other industry which can be quoted, for it and agriculture alone produce wealth absolutely de novo out of the ground. Agricultural wealth, however, is produced far more slowly than mining wealth, and especially in the case of cereals; agricultural wealth is not negotiable except in favourable situations, where there is a consuming population, or where cheap transport communicates with such a population. The wealth produced by mining, especially high priced metal and precious stone mining, is much freer from these considerations and is in a directly negotiable form almost independent of transport charges.

If these facts are thoroughly appreciated by the population at large, then there should be no difficulty in creating a public opinion in the Union which would stimulate the Government to take steps to encourage the mining industry in every possible way; the chief and infinitely the most important way being, in the opinion of the writer, the arrival at a compromise with the landowning classes, by which the whole Union, from end to end may be thrown open to prospecting.

The writer has been asked by certain members to suggest the lines on which he thinks such a compromise could be arranged. The following lines appear to him to be a framework on which a new law, acceptable to all parties, might be built:—

(1) The ownership and administration of all mineral deposits in the Union, not already worked or held under mining title, to be vested in the Government.

(2) The landowners to receive in compensation for their present rights a royalty of say five per cent. on the gross value of all minerals removed or sold from their land; or, alternatively a royalty on the nett profits of working, after the deduction of profit tax, say of fifteen per cent.

(3) The whole country to be thrown open to prospecting and mining, subject to reasonable reservations regarding homesteads, cultivated lands, water rights, etc.

(4) The prospector to lodge Government Stock to the value of £50, with the authority issuing his licence, as security for good behaviour and against judgment for damages.

(5) A prospecting licence to empower the licensee to enter any land, other than that reserved, and to sample and examine any rock, soil or formation, and to remove samples, but not to empower him to make any excavations more than 1 ft. in depth without the consent of the owner. The licence also to empower the licensee to camp and remain on any public outspan for one month at a time.

(6) The difference in the present law between precious and base metal claims and licences to be abolished, and all claims to be on one basis.

(7) A prospector, wishing to do further work, to lodge a further security of £50, and to take out claim licences as under the present Gold Law, the whole or half of these licence monies to go to the owner.

(8) Before a claimholder can abandon his claims and get a return of his security money, he must produce a quittance from the owner of the firm and from the Mines Department to say that he has either filled up his workings or made good for the disturbance caused by them.

(9) Any necessary surface rights needed by the miner to be paid for to the owner at a rate calculated on the valuation of the ground plus fifty per cent.; but these rights to lapse to the owner on the lapsing of the mining title to which they were attached and all material left on the ground at the lapsing of the title to become the property of the owner. In the case of any dispute the valuation to be settled by the Magistrate of the district, assisted by two assessors.

(10) In the case of any action against a prospector for crime, or for violating the terms of his licence, the Magistrate convicting him to have the power to suspend or cancel his licence and to deduct any fine from his security money.

(11) When the mineral development on any farm renders it desirable in the opinion of the Minister for Mines, that farm to be proclaimed a public mineral field, as under the present law, the Government to assume full control of

it, both surface and mineral, the owner, as at present, receiving half the revenue and his werf,but not the mynpacht as he receives compensation for that in royalties.

The author fears that his reply to this discussion has been long and very discursive. His excuse must be that the country is threatened with disaster from the closing down of its low grade mines. How near that disaster can be appreciated by anyone who studies the Chairman's speech at the last meeting of the Simmer Deep.

Only two methods can be found for postponing or tempering that disaster: the one is to keep the low grade mines going by facilitating their working in every possible way; the other is by finding new mines and industries to replace them as they fail. Both methods will be necessary if the disaster is to be averted.

The writer, being more conversant with the outside districts than with the low grade mines, has tried to indicate the second method. He trusts that some Witwatersrand members will come forward to emphasise the first method so that the whole weight of the Society may be thrown, and thrown quickly, into the great work of averting disaster, not only to the mining industry but to the Union as a whole.

AN UNUSUAL PROCESS IN THE TREATMENT OF GOLD ORE."

By Mr. B. L. Gardiner, B.Sc. (*Associate*).

(*Printed in Journal, January, 1919*).

C. J. Gray (*Member of Council*): I am interested in the author's statement that "The gold in the ore is very finely divided, and by panning a crushed sample of ore worth 7 dwt. by assay, a prospect of about 1 dwt. only is visible, and that very fine gold." Banded ironstones, which are common in South Africa, are probably, at least outside Rhodesia tested by the prospector by panning if he thinks it worth while to test them at all, and assays are not made unless panning gives a fairly satisfactory result. I myself have found gold in banded ironstone and without assaying decided that it was not worth further investigation. If panning results may sometimes be multiplied by a factor approaching 7 in magnitude it seems that that gold bearing ironstone at present disregarded may be valuable. I should like to know from the author, or others who may have had experience, whether it is common for assays of banded ironstone gold ores to be much higher than panning results.

Mr. A. F. Crosse (*Past President*): I have been asked to make some remarks on Mr. B. L. Gardiner's paper.

It was an interesting paper, and having carefully read it, I could find very little to criticise, especially as I know nothing about the ore in question.

I should like to have experimented on some of the ore; an analysis is wanting in order to show the minerals present, not the elements.

Sulphate of magnesia would hardly give up its sulphur in the treatment described.

I believe that the gold is coated in some way, so preventing contact with the cyanide solution.

SOME SUGGESTIONS ON IRRIGATION

By Mr. A. Baguley, B.Sc., F.I.C.
(*Member*).

(*Printed in Journal, March, 1920.*)

Mr. J. Watson (*Member*): In the new *Journal of Agriculture* which has just been published, by the Department of Agriculture of the Union of South Africa, there is a paper on "brak," by Mr. Arthur Stead, Lecturer in Chemistry, Grootfontein School of Agriculture, in connection with irrigation which should be of interest to Mr. Baguley.

The meeting then terminated.

Notices and Abstracts of Articles and Papers.

CHEMISTRY.

Method of Analysis of Fluorspar and Basic Slags Containing Fluorine.—Half a gram of the finely powdered sample is weighed into a dish, converted into a paste with 5 cc. of water, and evaporated nearly to dryness with 25 cc. of glacial acetic acid. A further 25 cc. of glacial acetic acid is added and the mass evaporated to dryness and then heated in a steam oven until all the acid has been expelled. The residue is transferred to a beaker, diluted to 80 cc., boiled, and filtered. The filtrate contains available lime (CaO and $CaCO_3$), soluble silicia, manganese, magnesia, and lead, whilst the residue contains all lime existing as CaF_2, silicia, iron, and alumina. The residue is ignited in a platinum dish, cooled, weighed, treated with hydrofluoric acid, evaporated to dryness ignited, and weighed. The loss in weight gives the amount of silica present. The remaining residue is treated with 5 cc. of sulphuric acid and evaporated until fumes are evolved, then it is ignited and weighed. The gain in weight is due to the formation of calcium sulphate from calcium fluoride. $CaSO_4 \times 0{\cdot}5735 = CaF_2$. The residue is boiled for 20 minutes with 20 cc. of hydrochloric acid, diluted, and precipitated by ammonium chloride and ammonia, boiled, filtered, ignited, and weighed. The weight is deducted from the weight of iron, aluminium, and calcium fluoride and gives the weight of calcium fluoride. If lead is present it must be removed before the iron and aluminium are precipitated. The filtrate is analysed in the usual way.—G. R. Doyle (*Chem. News*, 1919, 118, 304-305), *J.S.C.I.*, Aug. 15, 1919, p. 533 A. (A. W.)

Comparative Tests of Paliu and Rhotanium Ware as Substitutes for Platinum Laboratory Utensils.—Three gold-palladium alloys were tested; these had the following composition:—palau metal, gold, 80, palladium, 20%; rhotanium A metal, gold, 90, palladium, 10%; rhotanium C metal, gold, 70, palladium 30%. Rhotanium A ware is superior to platinum of both high and low iridium content in respect to its resistance to loss on heating; it is about equal to platinum as regards resistance to boiling hydrochloric acid, hydrofluoric acid, boiling 20% sodium hydroxide solution, and fusion with sodium carbonate and with potassium pyrosulphate. It is superior to platinum in resistance to boiling sulphuric acid, but inferior with respect to nitric acid, ferric chloride solution, and fuson with sodium hydroxide. It must not be heated above 1100° C. Both palau and rhotanium C ware behave in the same way towards reagents as does rhotanium A ware, except that they are not suitable for potassium pyrosulphte fusions. They are superior to platinum as regards resistance to loss on heating up to 1200° C. All three alloys may be used in electrolysis, but as cathodes only; as anodes they are useless.—L. J. Gurevich and E. Wichers (*J. Ind. Eng. Chem.*, 1911, 570-573), *Journ. Soc. Chem. Ind.*, July 31, 1919, p. 514 A. (J. A. W.)

Electroanalysis of Gold Without Platinum Electrodes.—Excellent results are obtained by the substitution of an iron anode for platinum, the cathode being of platinum gauze. The electrolyte is prepared by dissolving about 0·1 grm. of gold in *aqua regia,* adding 3 grms. of sodium hydroxide in 20 cc. of water, and 10 cc. of a freshly prepared 10% solution of potassium cyanide. During electrolysis the electrolyte is agitated and the temperature is raised to 60° C.; voltage 1·9 volts. Removal of the nitric acid by evaporation of the solution of gold in *aqua regia* is recommended in order to avoid a slight disintegration of the iron anode. The cathode is freed from gold by electrolysis in dilute hydrochloric acid. Excellent results were also obtained with the use of a cathode of very fine copper gauze previously nickel-plated. If copper is present in the gold to be analysed, 1 grm. of potassium cyanide is added in excess of the quantity required for solution of the precipitate, and the voltage is kept below 1·9 volts. The deposit of gold on the cathode is washed with 2% sodium sulphite solution, water, and finally alcohol.—J. Guzman (*Anal. Fis. Quim.*, 1919, 17, 115-120), *Journ. Soc. Chem. Ind.*, July 31, 1919, p. 514 A. (J. A. W.)

METALLURGY.

Lime as a Settling Reagent (in the Cyanide Process).—The proper settling of slime is of importance in cyanide mills where decantation is practised, and a knowledge of the manner in which lime functions as a settling agent is necessary for economical working. Poor settling may be caused when the pulp is of too high a viscosity, and increasing the temperature of the pulp so as to reduce the viscosity will result in more rapid settling. The time of settling also depends on the physical condition (fineness) of the slime. Quartz particles probably acquire charges of negative electricity which by inter-repulsive action retard settling. Lime dissolves with the production of positive ions in excess, thereby exercising a neutralising or discharging effect. A small quantity of lime may not neutralise all the negatively charged quartz particles, but owing to collison of the residual charged particles with other particles, the charge is distributed and rendered less intense, and the force of repulsion is then insufficient to hinder settling appreciably. An excess of lime may be regarded as neutralising all the negative charges, and then to some extent transferring a positive charge to the quartz particles, which again impedes subsidence. Lime is best added in the form of a spray of slaked lime, just below the surface of the solution in the thickener.—P. T. Bruhl (*Eng. and Min. J.*, 1919, 107, 1089-1090), *Jour. Soc. Chem. Ind.*, August 30, 1919, p. 583 A. (J. A. W.)

Utilisation of Waste Coal.—A report has been issued by a French Commission for the utilisation of waste coal, set up in July, 1918, to continue experiments started before the war by the Campagnie des Mines re Lens. Experiments have been made on the low-temperature carbonisation of a carefully chosen sample of coal residues from the Blanzy mines, the analysis of which was: Moisture, 2·1%; volatile matter, 23·3—23·6%; ash, 39·25—38·3%; nitrogen, 0·85—0·89%. The yield of ammonia when the coal was carbonised at 650° C. was only 7·4% of that calculated from the total nitrogen present, whilst at 950° C. it was 19%. By carbonising slowly at a low temperature, so that about one-third of the tar came over below 500° C. and the remainder below 680°, most of it below 550° C., a yield of 40 kilos. of tar per ton of material was obtained, comparing very favourably with the 20—25 kilos. obtained under gas-retort or coke-oven conditions. The low-temperature tar contained no naphthalene and a high proportion of phenolic substances, 13·3% against 1% in ordinary tar. It also gave a higher proportion of the more valuable light oils. The heavy oil, contining little aromatic hydrocarbons, was specially suitable for Diesel engines. The coke contained 5—6% of volatile matter. To make the low temperature treatment profitable it would be necessary to recover the rest of the nitrogen, and further experiments are necessary to determine whether this can be done by subsequent high temperature treatment of the coke. The yield of gas, which is low, may also be increased by this means.—H. Copaux (*Chim. et Ind.*, 1919, 2, 656-660), *Journ. Soc. Chem. Ind.*, Sept. 15, 1915, p. 614 A. (J. A. W.)

MINING.

Earth and Rock Pressures.—When orebodies whose tonnage is measured by hundreds of thousands are to be extracted by steam-shovel operations in open pits, it is necessary to determine if possible in advance the slopes that the sides of the pits will assume, for these slopes influence the shape of the excavations and thereby the amount of ore that may be extracted by the open-pit method. When large orebodies are mined underground at depths of 300 to 500 ft. (91 to 152 m.) by caving methods the surface subsiding as the ore is withdrawn, it is necessary to determine in advance the outermost limits of fracture in the subsiding surface, for on the delineation of these limits depends the location of surface improvements, mills, smelters, etc., and also the location of development work, such as hoisting shafts, main haulage levels, and all other underground openings that must remain undisturbed during the period of ore extraction.

In planning the development of underground-mining operations involving stopes of large area and at considerable depth, slopes of approximately 70° (½ to 1) should be projected upwards from the location of the outer boundaries of the stopes at controlling points and lines drawn connecting the intersection of such slopes with the surface. Within these lines will be contained the entire area of ground that will be disturbed by settlement cracks resulting from subsidence over the stopes, providing the rock is fairly homogeneous and there are no extensive fault planes or contacts between rocks differing greatly in hardness. Where extensive fault planes occur, consideration must be given to the possibility of extensive movement along such planes. In most cases, however, surface improvements and underground developments will be free from disturbance if located outside of the area delineated, but they are practically sure to be in danger if located within that area.

The series of comparisons of failures in materials ranging from damp sand to rock appear, to the writer, indications of the existence of a general law governing the line of rupture for all material possessing cohesion. The position of the line of rupture and its relation to the dimensions of the excavation appear to be independent of the angle of repose of the material and also independent of the amount of cohesion. It would also appear that the only material that can exert pressure upon a retaining wall or upon the sheeting of a cut is that which lies between the line of rupture and the retaining wall or sheeting. For a given depth of cut, always assuming the depth to be great enough to overcome the shearing strength of the material, the volume will be constant irrespective of the character of the material.—H. G. Moulton, Washington, D.C., *Mining and Metallurgy*, February, 1920. (W. A. C.)

MISCELLANEOUS.

Notes on the Settlement of Mine Water on the Witwatersrand.—The quantity of water which has to be handled by Rand mines has increased enormously within the last few years, chiefly on account of the steadily increasing efforts to deal with the dust problem. Thus, at the Village Deep Mine, the quantity of water used for the allaying of dust amounts to 256,000 gallons daily. The removal of the suspended matter is necessary, not only on account of the wear on the pumps, but since, if sufficiently purified, the required quantity may be circulated again throughout the mine, and thus save the necessity for fresh supplies from the surface.

In this paper the author gives a detailed account of the water storage and filtering system recently constructed at the Village Deep Mine.

There are eight settling sumps, each 28½ ft. × 10½ ft. × 11½ ft., of capacity 21,800 gallons. These are in two rows with a passage between. At the end of each row is a filtering sump 20 ft. × 10½ ft. ×11½ ft., and beyond these again the main storage sump, 156 ft. × 35 ft. × 12 ft. The excavation for the sumps is situated at 4,000 feet in the main incline shaft pillar. All the water from above this level is treated with lime by means of a mechanical feeder at the station above this level, whereby its acidity is reduced to ·002%. By means of a cross-cut from the shaft, this water, along with all water pumped from workings below this level is run to the settling tanks, special distributing launders being provided for each tank. Part of the overflow from these eight tanks runs to the two filtering sumps, where it passes through a bed of clinker and then through cocoanut matting; it is then sufficiently free from suspended solids to be circulated again for dust settling purposes throughout the mine. The remainder of the overflow from the settling tanks passes to the main storage sump. The portion of the water passing through the filter sumps is completely neutralized by the addition of a solution of sodium carbonate. The cost of lime and soda amounts to 1·96 pence per 1,000 gallons of water. The floors of the settling sumps have a 10% slope towards the sludge removal doors, which open into the central passage. The latter has a 3% slope leading to a sludge sump. From this sludge sump the mud from the periodical cleaning of the tanks gravitates to the level below, where it is filter pressed or transferred direct to skips and hoisted to the surface.

The following advantages for the above arrangement are pointed out :—

The excavation is rapid, a point often of considerable importance, because the removal of the ground broken is effected by means of tracks carried on an even grade from the level into the sump, a method both easy and inexpensive, and comparing very favourably with that of hoisting the broken ground out of an excavation below the drive level. The water used in drilling finds its own way out into the drive, and no water from the drive can enter the excavation, so that all water troubles are eliminated. Again, should there be a large increase in the water to be settled, or a rush of sand from sand filling, one unit can be cut out as often as desired, and the mud removed from it whilst the remaining sumps continue in operation. The settlers, as a whole, need never become full or get into such a condition that the mud cannot be removed when desired. In discharging mud only one-eighth of the settling capacity is cut out, and then only for two hours. Further, the water to be pumped is above the level of the pumps and gravitates to them.

Valuable experimental data on the effect on the rate of settling of (1) acidity and alkalinity of the water; (2) proportion of suspended matter, are included in the paper. For complete details of these the original paper must be consulted. The conclusions reached were, that for the best results the water should be distinctly alkaline. The best results were obtained by adding a certain amount of sodium carbonate solution to the distributing launders in addition to he lime added previously. Further, it was found, by very complete tests on one of the settling sumps, that up to about a rate of 7,000 gallons per hour, very little difference in the percentage of suspended solids in the overflow from the settling tanks was found. Taking 7,000 gallons per hour as the quantity at which the best results possible are obtained, the total capacity of the settlers is 56,000 gallons per hour.

The total cost of excavating and constructing the sumps was £4,726. The operation of the new sumps commenced at the end of March, 1919. The cost of pumping for January, 1919, was £4,445, and for May, 1919, £2,729.

This reduction in pumping was due to the replacement by filtered mine water, of water which previously had to be sent from the surface, and also to the saving in pump spares, which was considerable when clear water was dealt with.—J. Whitehouse, B.Sc., *Journal S.A.I.E.*, Aug. 1919, pp. 8-22. (H. R. A.)

Heat Insulation and Lagging Materials.—"The most efficient lagging for boilers, steam-pipes and engines is 'magnesia covering' composed of hydrated magnesium carbonate 85%, and asbestos fibre 15%; it has a density of 12-15 lb. per cub. ft. and will retain 85-87% of heat which would escape from an uncovered pipe. Silicate cotton or slag wool is an efficient lagging material, but when subjected to vibration it is reduced to half its original volume. None of the various asbestos materials is as efficient as magnesia. Various plastic compounds containing kieselguhr, felt, clay, lime, etc., are also used for lagging purposes. Furnace settings are chiefly lagged with very light, porous silica bricks having a honeycomb structure, and a density of 30-35 lb. per cub. ft. (compared with 112-125 lb. for common bricks and 137-150 lb. for firebricks). The following figures show the heat lost from a pipe lagged with various materials each 1½ in. thick, with steam at 400° F. (204—5° C), and an outside temperature of 68° F. (20° C.) :—

Magnesia, 118 B.Th.U.; blue asbestos, 121; mica (best only), 123; white asbestos, 126; plastics, etc. (best), 133; plastics, etc. (inferior), 143; bare pipe, 1070 B.Th.U. per sq. ft. per hour. The graph representing the ratio of the heat-loss to thickness of covering of magnesia is almost hyperbolic, so that complete insulation is impossible. For a temperature of 400° F. (204—5° C.) covering more than 1½ in. thick is of little additional value. For temperatures above 400° F. a thickness of 2 in. is necessary. The thickness of covering which will give the maximum retention of heat at minimum cost is most readily ascertained by such a graph. Where an acid-resisting lagging is required, magnesia covered with an acid-resisting coating is best."—J. S. F. Gard.—*Nat. Assoc. Ind. Chem.*, Jan. 11, 1919.—*Journ. Soc. Chem. Ind.*, Feb. 28, 1919, p. 97a. (J. A. W.)

Abstract of Patent Applications.

246.1919. Nitrogen Products' and Carbide Co., Ltd. Improvements relating to the destructive distillation of carbonaceous materials. 8.4.19.

This application relates to destructive distillation of carbonaceous materials at low and moderate temperatures.

The aim of the applicant is to obtain improved products by the use of a continuously operated retort, by passing inert gas or steam through the body of the charge.

247.19. S. Z. de Ferranti. Improvements relating to heat engines. 8.4.19.

This application refers to improvements relating to heat engines, more especially to internal combustion engines, whether operating on the rotary or reciprocating principle.

There are 25 claims, but the general principle involved is that of combining forced feed for the fuel and compressed air at high pressure and maintaining the working cylinders at about red heat, and in this combination a regenerator is also made use of.

591.19. Aktiebolaget Kvafveindustri of Kopmanagotan. Improvements in processes for carrying out chemical reactions between gases and solid substances at high temperatures in continuous working. 28.7.19.

This application is for a chemical process for the manufacture of cyanides and other nitrogen compounds.

The process carries out a re-action between coal and alkaline earth metals in a current of nitrogen in which impurities such as silicic acid and alumina are decomposed by carbonic acid or precipitated by means of calcium oxide.

592.19. Aktiebolaget Kvafveindustri of Kapmanagotan. Improvements in processes for carrying out chemical reactions in the presence of metals in a finely divided form. 28.7.19.

This application is for a chemical process for the manufacture of cyanides and other nitrogen compounds. It is directly related to Patent Application No. 591.19.

The process carries out a re-action between coal and alkaline earth metals in a current of nitrogen. A special feature of the claim made is the addition of finely divided metal such as iron to the mass before heat is applied. A special method of preparing iron is described. The action of this metal appears to be a catalytic one.

711.19. A. O. Crozier. Improvements in the method of and apparatus for cementitious articles. 3.9.19.

This application refers to the method of making cementitious articles, which consists in establishing in an upright hollow shaft or container a column of slushy cementitious material of a height sufficient to cause its own weight to effect a substantial compacting of its lower portion, mechanically compresing the lower portion only of the column to further compact or densify the same, severing a section from the compacted lower portion of the column, removing the severed section and permitting the remaining portion of the column to descend, and maintaining the height of the column by the addition of cementitious material to the upper part thereof.

There are twelve claims altogether, giving particulars of the method of application of the principle involved.

756.19. O. H. Pratt. Improvements in and relating to safety catches for cages in mine shafts or other elevators. 18.9.19.

This application refers to safety catches for cages in mine shafts or other elevators and generally comprises a level mounted on a movable crossbar operated by springs through links with gripping jaws, etc.

Seymour Memorial Library.

The following books have recently been added to the Library:—

"The English-Speaking Brotherhood and League of Nations," Walston, Charles, 1919.

"The Society of Free States," Morrow, Dwight, 1919.

"Agricultural Bacteriology" (Third Edition), Conn, H. W., 1918.

"Experiments in International Administration," Sayre, F. B., 1919.

"Forestry for Woodmen," Hanson, C. O., 1911.

"Constitutional Power and World Affairs," Sutherland, George, 1919.

"Boiler Chemistry and Feed Water Supplies," Paul, J. H., 1919.

"The Scientific American Cyclopedia of Formulas," Hopkins, A. A., 1918.

"The Mica Miner's and Prospector's Guide," Dickson, A. A. C., 1919.

"The Preservation of Wood," Wallis-Taylor, A. J.

"The Kiln Drying of Lumber," Tiemann, N. D.

"Practical Photo-Micrography," Barnard, J. E.

"Engineers' Costs and Economical Workshop Production," Smith, Dempster, and Pickworth, P. C. W.

"The Principles, Operation and Products of the Blast Furnace," Johnson, J. E.

"Blast Furnace Construction in America," Johnson, J. E.

"The Analysis of Minerals and Ores of the Rarer Elements," Schoeller, W. R., and Powell, A. R.

"The Rise of South Africa (Vol. III.), Cory, G. E.

"The Prac. Electrician's Pocket Book and Diary," 1919.

"Questions and Solutions in Telegraphy and Telephony Final Examinations," Faw, H. P.

"Questions and Solutions in Magnetism and Electricity," White, W. J.

"Telephone Election and Maintenance," White, W. J.

"The Application of Arc Lamps to Practical Purposes," Eck, Justus.

"Oxy-Acetylene Welding of Copper, Brasses and Bronzes," Amedeo, M. B.

"How to Estimate, being the Analysis of Builders' Prices" (Fourth Edition), Rea, John T.

"The Principles of Iron Founding" (First Edition), Moldenke, R.

"The Fitting and Erecting of Engines," Browne, C. L.

"Practical Oil Geology," Hager, D.

"Valves and Valve-Gearing," Hurst, Chas.

"Practical Treatise on Gearing" (Eleventh Edition), Brown & Sharpe Manufacturing Co.

"Formulas in Gearing" (Seventh Edition), Brown & Sharpe Manufacturing Co.

"Glass Manufacture" (Second Edition), Rosenhain, Walter.

"A Handbook of Colloid Chemistry," Ostwald, Dr. W.

"Catalytic Hydrogenation and Reduction," Maxted, E. B.

"The Chemists' Year Book" (I., II., 1918-19), Atack, F. W., and Whinyates, L.

"The Theory and Use of Indicators," Prideaux, E. B. A.

"Inductive Interference Between Electric Power and Communication Circuits," Railroad Commission Report.

"Mining Manual," 1920, Skinner.

"Theory and Calculation of Elec. Circuits," Steinmentz, C. P.

"The Prescriber," Vols. XI., XII.

Changes of Address.

CADDY, J. P., *l/o* Kalgoorlie, W. Australia : Thornleigh Road, Beecroft, New South Wales.

SMYTHE, J. J. R., *l/o* Village Main Reef, G.M. Co., Ltd. : Ferreira Deep, Ltd.

WATSON, F. W., *l/o* Cons. Goldfields Laboratory, Germiston ; Rand Mines Laboratory, Box 1056, Johannesburg.

AYMARD, M., from Active Service : c/o Technical Book Shop, Salisbury Hse., London, E.C 2.

FIANDER, R., *l/o* Florida : New Heriot G.M. Co., Ltd., P.O. Box 10, Cleveland.

HONNOLD, W. L., *l/o* Corner Hse., Johannesburg : Room 2222, 120 Broadway, New York, U.S.A.

JANSSEN, P. J. : c/o Mijnbouw Maatschappij, Simau, Batavia.

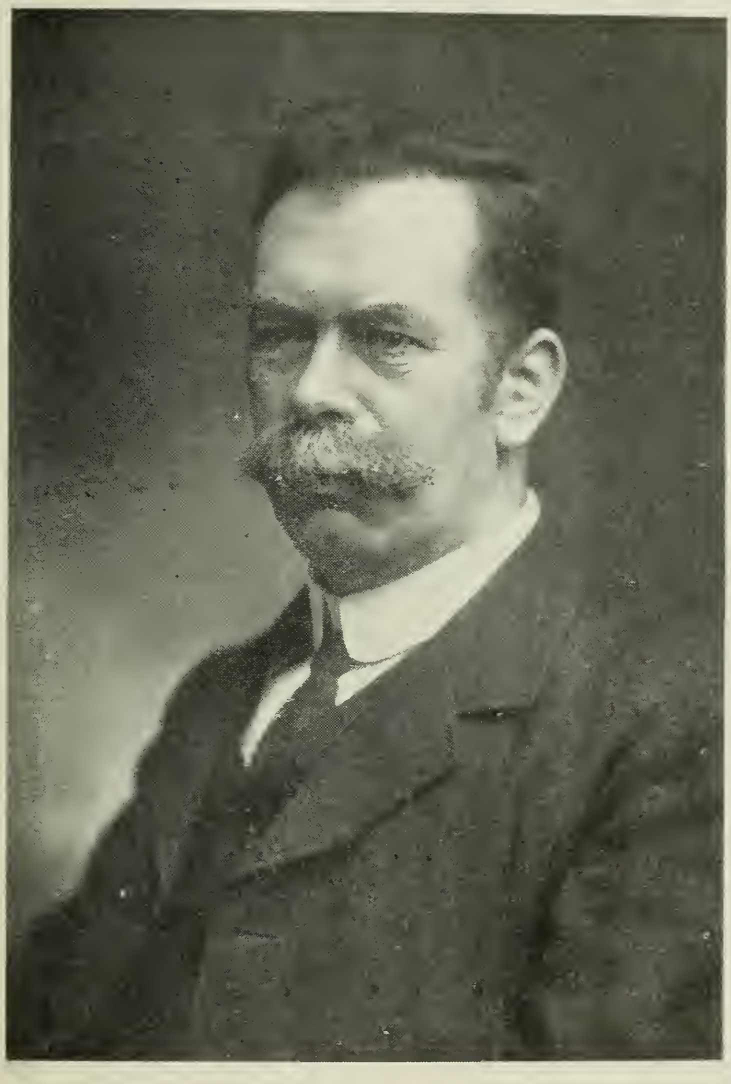
MELVILLE, G., *l/o* Maraisburg : Village Deep, Ltd., P.O. Box 1064, Johannesburg.

PRICE, W. S. V., from Active Service : P.O. Box 36, Maraisburg.

STEVENS, T. B., *l/o* Kalgoorlie, W.A. : P.O. Box 5, Fimiston, W.A.

WILSON, G. C. : Private address, 55 Fifth St., New Township, Springs.

WOOD, J., *l/o* Roodepoort : Staff Qrs., P.O. Box 103, Crown Mines, Johannesburg.



With regards

John S. MacArthur.

THE LATE JOHN STUART MACARTHUR.

THE JOURNAL
OF THE
Chemical, Metallurgical and Mining Society
OF SOUTH AFRICA.

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Proceedings
AT
Ordinary General Meeting,
May 15, 1920.

The Ordinary General Meeting of the Society was held in the South African School of Mines and Technology Building, Johannesburg, on Saturday, 15th May, 1920, Mr. Jas. Gray (President) in the chair. There were also present:—

19 Members: Messrs. J. Chilton, G. A. Watermeyer, C. J. Gray, J. R. Thurlow, F. W. Watson, H. A. White, G. Hildick Smith, Prof. J. A. Wilkinson (Members of Council), L. Marks, H. Rose Martin, J. M. Neill, W. S. V. Price, Dr. A. J. Orenstein, C. B. Simpson, H. S. Steels, A. Thomas, J. Watson and H. R. S. Wilkes.

4 Associates: Messrs. J. A. Boyd, Samuel Evans, J. Gibson and R. W. Irwin.

19 Visitors, and H. A. G. Jeffreys (Secretary).

MINUTES.

The Minutes of the Ordinary General Meeting, held on 17th April, 1920, as recorded in the April *Journal*, were confirmed.

NEW MEMBERS.

Messrs. F. W. Watson and J. Watson, having been elected as scruitneers in connection with the ballot for the election of new members, the following were declared unanimously elected:

Kahan, Raoul Robellaz, Transvaal Chamber of Mines, Johannesburg. Refinery Manager.

Prentice, Thomas Kennedy, 78, 12th Avenue, Mayfair, Johannesburg. Metallurgist. (Transfer from Associate Roll.)

Ritchie, Jerome, West Rand Consolidated Mines, Ltd., P.O. Box 38, Krugersdorp. Chief Surveyor.

The Secretary notified that Mr. George Appleby Topper had been admitted by the Council as an Associate.

General Business.

JOINT HOUSING SCHEME.

The President: As a result of the appeal for donations which has been issued to Members and Associates, in connection with the Joint Housing Scheme, we have already received or been promised £89 15s. from the Members of the Council, and the Members and Associates of the Society, and through the efforts of one of our Members of Council a further £50 has been received from another source, making a total to date of £289 15s., that is including the £150 which has been donated from the Society's funds. This is a most satisfactory position, and I hope by next month it will be considerably increased.

ANNUAL ELECTION OF OFFICERS AND COUNCIL.

The President: I would ask you to propose scrutineers for the conduct of the ballot for the election of Office-bearers and Members of Council next month.

Mr. F. W. Watson (*Member of Council*): I beg to propose Messrs. P. T. Morrisby, S. Newton, E. A. Osterloh and A. Thomas.

Agreed.

PRESENTATION TO MR. F. ROWLAND.

The President: It is proposed to close the subscription list in connection with the presentation to Mr. Rowland a few days before the 26th June, that is, the date of our Annual Meeting, in order that the presentation may be made at that meeting. I hope those who have not sent in their subscription will do so as soon as possible.

RESEARCH ENDOWMENT FUND.

Prof. J. A. Wilkinson (*Past President*): I have much pleasure in proposing the following resolutions:—

1. That this General Meeting of Members considers that the donations received in response to appeals for funds to provide prizes for Papers should be held by the Society as a special Trust Account, to be known as the "Research Endowment Fund," the moneys to be invested in the name of the Society in such securities as are commonly known as "Trustee Stocks," the yearly revenue from which shall be devoted to the following objects:—
   (a) Providing medals or other prizes as the Council may direct for the best paper or papers read before the Society during the year;
   (b) Providing moneys which may be donated to research workers for the provision and to defray the cost of the apparatus or other material necessary for the conduct of research, such apparatus to revert to the Society or otherwise as determined by the Council;
   (c) Providing any other means whereby research in connection with Chemistry, Metallugry and Mining may be stimulated and encouraged.
2. That this General Meeting of Members further requests the Council to take such steps as may be necessary to amend the Constitution of the Society in order to ensure that the "Research Endowment Fund," shall be utilised solely for the purposes above described.

In support of these resolutions I may say that during the last two or three months your Council has been engaged in appealing for funds to encourage papers being read before this Society by giving medals or other kind of recognition to the one, who, in the opinion of the Council, reads the best paper. We hope the response to this appeal will be excellent. So far it has been very encouraging, and we have in hand already, from three chemical firms in this country a sum of £156 5s. Other firms have been approached, and we have reason to believe that the response will be just as good.

The question now is: What should this Society do with this money?

Older Members of the Society will remember that some years ago the Mining Houses here donated sums of money for this purpose, and medals accompanied with cheques of £50, for the best-written papers during those particular years were granted, until all the available moneys were exhausted. The present Council, however, is of the opinion that this method is not a good means of stimulating research, and even at that time many people felt the rewards were given for papers which did not deserve such an award, as some of them were of very indifferent merit.

The Council, therefore, feels that the money to be obtained now should be retained by the Society in perpetuity, and that prizes and other means of stimulating research should be given year by year from the revenue, which is given by the capital sum. This should be properly invested by trustees appointed by the Council, as stated in the motion under the term Trustee Stocks. I am afraid that with the moneys we shall probably get now we shall not be able to do much more than provide medals out of the revenue accruing from this particular fund; but it is hoped in future that this fund will grow, and this Council may well leave it as a legacy deserving of the utmost sympathy to future Councils of this Society.

In most modern Scientific Societies of any standing such funds as the one proposed to be instituted here have existed for some considerable time, and in several these run into five figures, yielding yearly revenues, which amount to hundreds of pounds. The latter is expended in assisting research workers to purchase the necessary material required for their various researches and it can readily be understood that in the absence of such assistance much work of a valuable nature could not be undertaken at all, or at least would be undertaken with a considerable handicap. In this country also one does not find even the necessary literature, which research workers always require, and, provided that, in the opinion of the Council, there were not during any given year any papers of sufficient merit, I can conceive no reason why the revenue from a fund like the one now proposed should not be used for assisting suitable provision in this respect.

Further, in this country the Government has established research scholarships, but the amounts granted are generally of such magnitude as to enable the worker, who is supposed to devote the major portion, if not the whole, of his time to the work, merely to pay his living expenses, and in such case it is impossible for him, unless he possesses private means, to undertake the work. The establishment by this Society of such a fund as now contemplated will serve to bridge this gap, enable these researches to be carried out, and the papers to appear in the Society's *Journal*. In this connection the fact that expensive apparatus or other material has to be purchased for research work must be fully borne in mind. All this I have attempted to cover in the first proposal.

The second resolution merely requests the Council to take such steps as may be necessary to amend the Constitution of the Society, because the idea is that this money shall not be at once spent, but that it shall form a Trust Fund and that the revenue from this Trust Fund shall be used each year, or, if it is not used, it shall revert and be added to the capital of the Fund itself, and that this shall be a trust left in perpetuity for future generations of workers and contributors to the Society's aims and objects. This is no reason why future Councils should not attempt to add to this Fund, so that it shall bring instead of a yearly revenue of an approximately small amount one of several hundreds. When the Council has in its hands such a yearly revenue as the latter it will be indeed able to stimulate research work, as stated in the first resolution. I have very much pleasure in proposing the two resolutions.

Mr. G. Hildick-Smith *(Past-President)*: I have much pleasure in seconding the resolutions proposed by Prof. Wilkinson. I think if we can obtain contributions, be they only small ones, it will be a step in the right direction.

The resolutions were then put to the meeting and declared carried unanimously.

ANNUAL DINNER.

Mr. John Watson: I should like to propose a very hearty vote of thanks to the Dinner Committee for the very excellent dinner we had last Saturday, the first since the war.

The President: On behalf of the Dinner Committee, I thank you.

AN UNUSUAL PROCESS IN THE TREATMENT OF GOLD.

By B. L. Gardiner, B.Sc. (*Associate*).

(*Printed in Journal, January, 1920.*)

DISCUSSION.

Mr. F. Wartenweiler *(Member of Council)*: This paper, presenting the solution of a problem, is undoubtedly one of technical interest and of considerable value to those confronted with the treatment of an ore having similar characteristics. The account of the evolution of the process appeals to me as an example of logical deduction and of balance between technical efficiency and economic considerations.

The immediate and practical effect of the heat treatment appears to render the ore permeable to cyanide solution by dehydrating or driving off water of combination.

I regret that I am unable to add to the stock of information so freely described except that I am under the impression that ores from the Republic Mine, Washington, yielded to similar treatment, which, however, was never carried beyond the laboratory stage.

In the way of constructive criticism; it is not clear why such a high strength of cyanide solution as 0·17% with its presumably high cyanide consumption is used in leaching the baked ore. I think that fellow-metallurgists will join me in thanking Mr. Gardiner for bringing this valuable paper before our Society.

THE GOLD PREMIUM.

By S. Evans (*Associate*).

It is not my intention on this occasion to attempt to deal comprehensively with the currency problem. As far as possible, I shall confine my remarks to what seems to me essential in order to appreciate the why and the wherefore of the gold premium. But a profitable discussion of that premium is out of the question without some understanding of the fundamental principles involved. Indeed, in dealing with the present premium on gold the only way to avoid pitfalls is to keep the theory of money constantly in mind.

I have recently read a few of the numerous books and pamphlets on the currency question which appeared in England in the first half of last century, and in the United States from 1862 to the end of the century, and I have come to the conclusion that, as regards the problem of money at any rate, the Sage was right: "There is no new thing under the sun." As far as I can see, living authorities on money have nothing much to tell us which was not told to our forefathers by David Ricardo, and later by General Francis A. Walker; and the modern champions of inconvertible paper currency have no arguments which were not used by Vansittart and other opponents of the Bullion Committee in England, and by E. G. Spaulding and other adherents of the National Greenback Party in the United States.

For a period of seventy years from the passing of the Bank Charter Act in 1844 up to the outbreak of the Great War England possessed a monetary system which compared favourably with that of any other country. It worked automatically and required little or no attention. Consequently, in recent times politicians and business men have shown an increasing tendency to regard the teachings of economists on monetary science as "the visionary speculations of idealists," mere academic theorising of no practical value and certainly not worth serious study, even by merchants and bankers. Twenty-five years ago Mr. Robert Barclay wrote:—

> "Monetary science is something different both from finance and from banking, and we know that the full study of it is as much shirked both by merchants and bankers as by other classes." (P. vi., "The Disturbance in the Standard of Value.")

The currency question was a live issue in England for more than a generation prior to 1844. The Parliament which passed the Bank Charter Act contained a large number of members who were thoroughly conversant with the subject. In the main they were disciples of Ricardo and believers in the doctrines propounded in the Report of the Bullion Committee of 1810. Judging by recent discussions in the Imperial Parliament and elsewhere one would think that Ricardo was a doubtful guide on currency questions and that the Report of the Bullion Committee was completely out of date—a back number hardly worth reading except, perhaps, as an historical curiosity. That, however, is not the view of the masters. The doyen of living English economists, Professor Marshall, says that "the brilliant school of deductive reasoning which Ricardo led was here (on the theory of money) on safe ground;" Ricardo's "strong constructive originality is a mark of the highest genius in all nations." ("Principles of Economics," page 61.) The late Professor Thorold Rogers wrote:—

> "On money and banking, on currency questions generally, and especially on the most abstruse of them, Ricardo's authority is of the highest character. Here he was in his element." ("Economic Interpretation of History," page 185.)

"Ricardo," writes Professor Nicholson, "is perhaps the greatest of all writers on currency." (Inflation, page 33.)

Professor Nicholson also quotes with approval Bagehot's remark that the opinions of the bank directors who opposed the Report of the Bullion Committee "have become classical by their nonsense." (Bagehot probably used the term "nonsense" because it appears to have been a favourite epithet of the opponents of the views of the Bullion Committee from 1810 onwards, including the Directors of the Bank of England and Vansittart. Mr. Asquith has now taken a seat on the same platform.) H. D. Macleod in his "Theory and Practice of Banking" (Vol. II., page 93), says—

"The grand principles of the Bullion Report are not what are properly termed matters of opinion at all, but of demonstration. . . . They are matters of pure geometrical demonstration."

Professor W. G. Sumner, of Yale, writing in 1874, said—

"So much, however, in regard to the laws which govern paper issues, as was laid down in the Bullion Report, is established beyond dispute. Its doctrines are the alphabet of modern finance" (p. 308 "History of American Currency").

As I have indicated the principles which Ricardo and the Bullion Committee enunciated are almost entirely—I might even say contemptuously—ignored to-day. They were quite recently described by Mr. Asquith as "the greatest nonsense," "crude and ill-considered expedients," and the believers in them as the "imperfectly instructed." Speaking in the House of Commons on Monday, March 15th last, Mr. Asquith said that:

"The rise in prices, which is the direct and inevitable consequence of the War, is a world-wide rise. It is not a domestic rise; it is an international rise. . . . There is no greater fallacy than to suppose that high prices are due to the multiplication of currency. It is the greatest nonsense, although it still finds favour in some imperfectly instructed quarters. They are both consequences of the same series of collocations, and to think that you can by the simple expedient of contracting your currency bring down prices is—to use a favourite metaphor of Mr. Bright—like the man who sold pills against earthquakes. You will not get rid of the difficulty by crude and ill-considered expedients like that."

He explained that the rise in prices was due to under-production and to over-expenditure. It is obvious that Mr. Asquith is not a student of the Supreme Economic Council's Monthly Bulletin of Statistics. A glance at that Bulletin would have taught Mr. Asquith the correctness of a statement made by Professor Irving Fisher, of Yale University, in a work just published entitled "Stablising the Dollar":

"For the period of the recent war," writes Professor Fisher, "we can arrange the different countries in the approximate order in which their prices rose. As a result, we find that the order of the nations corresponds in general with the order in which the currency in these nations has been inflated by paper as well as with the order in which their monetary units have depreciated in the foreign exchange markets. . . . It is a common impression that wars always raise prices. But a study of index numbers in the belligerent countries, during the Napoleonic wars, war of 1812, Mexican, Crimean, Civil, Franco-Prussian, Spanish-American, Boer, Russo-Japanese wars, and World War, indicates that war seldom raises prices except when, and to the extent that, the costliness of the war forces recourse to inflation as a fiscal expedient of governments or their people."

Some forty years ago Professor Thorold Rogers wrote—

"Our English Parliament in the present (nineteenth) century endorsed the follies of Vansittart and repudiated the truths which were announced by the Bullion Committee and Lord King." ("Six Centuries of English Work and Wages.")

This might have been written to-day as what Mr. Asquith has been saying is precisely what Vansittart said in 1811. Sir Robert Peel, who voted in favour of Vansittart's resolutions condemning the principles advocated by the Bullion Committee, lived to become the greatest parliamentary champion of those principles. It is to be hoped that Mr. Asquith will also live to see the error of his ways and perhaps take a leading part in helping to bring the British Parliament back to sound money. At present unfortunately the study of the currency problem is neglected in Great Britain. Although England has had a practically inconvertible paper money for well over five and a-half years comparatively little attention has been paid to the subject by members of Parliament, the Press, and the general public. When I was in London at the end of last year I asked a well-known second-hand bookseller, who specialises in literature on political economy and finance, if there was much demand for the works of Ricardo and the Bullionists? "Yes," he replied, "but chiefly from Japanese and Americans."

When the War broke out in 1914 England had a gold standard currency. The Bank of England notes were payable in gold on demand; they could only be issued against gold except as regards £18,450,000 which were issued against securities, and no notes of a lower denomination than £5 could be issued. In Scotland and Ireland the banks had in circulation a comparatively small quantity of notes, which were also payable in gold on demand. Generally, it may be said that in the middle of 1914 the business of the United Kingdom was done mainly by means of metallic currency or cheques.

Many things have been used as money, but all civilised countries in all ages have adopted the precious metals as the medium of exchange, the denominator of value and the standard for deferred payments. For some centuries up to 1873 silver was the predominant money; since, gold has steadily replaced silver, and was at the time the War broke out the monetary standard of nearly all civilised countries. No other commodities possess the required qualities in so large a degree. These qualities include: general acceptability, portability, divisibility, durability and constancy and uniformity of value. The last is by far the most essential quality of good money. It should be a just standard for deferred payments. A farmer sells his mealies or his fat stock for a given price to-day; if some months later when he comes to use the money he received there is a considerable rise in prices he incurs a loss which would not have happened had the two transactions taken place simultaneously, or had he not used money at all but simply bartered his produce for the commodities he desired to have. "That commodity upon the whole will possess the greatest uniformity of value, the production of which demands the greatest uniformity of sacrifice on the part of those who obtain it; the supply of, and the demand for, which are subject to the least degree of sudden and considerable increase and diminution, and which at the same time is the most durable. ("Remarks on Currency and Banking," by G. W. Norman.) In all these respects gold possesses incontestable superiority; although the course of prices up to the outbreak of the War showed that the output of money was excessive, including, of course, not only gold but also paper substitutes for gold. In this connection, the attached statement (Appendix No. 1) shows that since the commencement of gold production on any scale in the Transvaal the cost of producing an ounce of fine gold was remarkably uniform up to the outbreak of the War.

Money facilitates the exchange by man of the things he produces and does not want for the things he wants and does not produce. He sells his surplus products for money and then sells the money for other men's surplus products. Money is governed by the same laws as other commodities. If there is too much of it it depreciates in value; that is, an increased quantity of it has to be paid for a given quantity of other commodities. If there is too little of it it appreciates in value; that is, other commodities fall in price. Dr. N. G. Pierson in his classical treatise on Economics, after answering the arguments adduced against the quantity theory, writes:

> "To reflect upon the important problems which arise in connection with that theory is of no avail until we have learned to regard money as an ordinary article of merchandise, subject, like all such articles, to alternations of redundancy and scarcity, and, as regards the fluctuations in its value, subject to the laws of supply and demand." (Principles of Economics, Vol. I., page 399.)

Ricardo said:—

> "Quantity regulates the value of everything. This is true of corn, of currency, and of every other commodity, and more perhaps of currency than of anything else."

In his reply to Mr. Bosanquet's "Practical Observations" Ricardo wrote:

> "That commodities would rise or fall in price, in proportion to the increase or diminution of money, I assume as a fact that is incontrovertible."

Mill said:

> "That an increase in the quantity of money raises prices and diminution lowers them is the most elementary proposition in the theory of currency and without it we should have no clue to any of the others."

Practically all fallacies and misconceptions about currency, prices, and the high cost of living, are due to the fact that people fail to realise that the general level of prices depends on: (1) the volume of money in circulation, including bank deposits subject to cheque, (2) the pace at which it circulates, and (3) the volume of trade. That is the quantity theory. Professor Kemmerer states that—

"From the infancy of economic science to the present time it has been the most generally accepted theory of the value of money."

Professor Nicholson says that—

"Practically every economist of repute since Ricardo,"

has been an advocate of the quantity theory. Adherents of this theory include Locke, Hume, Adam Smith, Ricardo, Mill, Jevons, Walker, Sumner, Marshall, Nicholson, Cannan, Hadley, Seligman, Taussig, Irving Fisher, Kemmerer, and nearly all writers on the subject.

It will help us to get a clearer conception of the position if we eliminate money altogether and think in terms of things only. The main use of money is to enable commodities to be exchanged for commodities. "Gold," said Bosanquet, "produces no benefit to the holder as gold; he cannot eat it, nor clothe himself with it; to render it useful, he must exchange it either for such things as are immediately useful, or for such as produce revenue." Let us imagine that there is no money, either specie or paper, and that any given producer has to take services or goods and not money in exchange for what he produces. In Appendix 2 I have attempted to show the position in 1919 compared with 1913 of each group of producers in the United Kingdom, supposing money was not used and that goods were bartered for goods. It will be seen that the variations in value in 1919 compared with 1913 are small when measured in commodities. For instance, although the products of the metal and mineral group have trebled in money price since 1913 their value in 1919 measured in other commodities is only 15·8 per cent. higher than it was in 1913. It will be noted that measured in other commodities food and drink were cheaper in 1919 than in 1913. No doubt a part of the lower exchange value of food is due to the bread subsidies. On the other hand, the exchange value of meat is probably too high. "There is more meat available for export in the world to-day than ever there was; there is greater frozen storage capacity, there is far greater refrigerator-steamer capacity. And there is less consumption." (Boyd Cable in "Ways and Means" Supplement of March 27th, 1920.)

The differences in the commodity values of the various groups of products, taking 1913 as a basis, were slightly less marked in 1918 than in 1919, as will be seen from the following comparison:—

		Board of Trade Index Numbers 1913 equal 100.		Variations, taking the average of all Groups as 100.	
		1918.	1919.	1918.	1919.
i.	Metals and Minerals	221·5	302·0	96·5	118·7
ii.	Textile Raw Materials	262·6	276·6	114·4	108·8
iiia.	Corn, Grain, etc.	218·7	242·5	95·3	95·4
iiib.	Meat, Fish and Dairy Produce ...	218·9	228·5	95·4	89·9
iiic.	Colonial Produce, Tobacco	240·5	266·6	104·8	104·8
iiid.	Beverages	197·8	230·2	86·2	90·5
iii.	Total	220·3	237·4	96·0	93·4
iv.	Sundry Materials	245·4	289·2	106·9	113·7
	Averages	229·5	254·3	100·0	100·0

Even a considerable portion of the more important of the above variations can, I think, be traced directly or indirectly to currency inflation. Currency inflation does not press evenly on all commodities. The prices of those commodities which are produced by workers who have well-organised labour unions respond to increases in the cost of living much quicker and to a greater extent than those in which the workers are not organised. Then, again, currency inflation has a far greater influence on the price of some raw materials than on others. Cotton is an instance. Currency inflation by means of the printing press has, I believe, been carried further in Egypt than in any other portion of the British Empire, with the result that the fellaheen have been able to secure highly inflated prices for their raw cotton; and, as the Egyptian pound has not depreciated as compared with sterling, all other producers of cotton have been placed in a position to command in England prices about equal to those paid to the fellaheen. A detailed and searching enquiry would, I believe, lead to the conclusion that the inflation of the currency has been the primary cause not only of the great rise that has taken place in the general level of prices, but also of the more important of the differences in the last two years as compared with 1913 between the exchange value in commodities of various groups of products; and that in nearly all cases inadequate production has been an almost negligible factor.

Lord D'Abernon, speaking in the House of Lords on November 26th last as to the bearing of scarcity on rising prices, pointed out:

(1) That such articles as old books pictures by old masters, jewels, old furniture, and other articles where the question of new production does not come in or comes in to a very minor extent, had gone up in price practically in the same proportion as articles of annual production such as wheat, meat, sugar and coal.

(2) That dividing articles of annual production and immediate consumption into two classes, namely, articles where a short-fall has occurred and articles where it has not, it is found that there is a comparatively small difference between the rise in one class and the rise in the other—less than the arithmetical proportion of the deficiency to the total.

(3) That the relative rise in the price of articles for which there was a special war demand, such as iron and steel, compared with other articles not specially affected by the War, though considerable, had been smaller than the enormous special demand would have led one to expect.

Lord D'Abernon asked—

"Is any explanation of these paradoxical facts possible other than that the action and effect of short supply and of abnormal demand has been snowed under and largely obliterated by the action and effect of a more powerful cause—namely, the depreciation of money which has affected similarly both the plentiful and the deficient, both the articles in exceptional war demand and the rest."

The fact is the present state of affairs in the world is simply a repetition on an unprecedented scale of what has always happened when there has been a great money inflation. It is in entire accord with what the advocates of the Quantity Theory predicted would be the result of the creation of a superabundance of currency. For instance, in a remarkable article written in 1907 Mr. Byron W. Holt, of New York, pointed out that an increase in the supply of money causes the general level of prices to rise and that—

> "Rising prices of commodities and property encourage speculation in commodities, stocks and real estate and discourage honest industry. Thus rising prices, by diminishing the incomes of safe investments in gilt-edged bonds and stocks, and by increasing the profits of speculators, encourage extravagance, recklessness and thriftlessness. As rising prices decrease the purchasing power of debts, and thus aid debtors at the expense of creditors, they discourage saving and thrift. . . . A prolonged period of rapidly rising prices is reasonably certain to become a period of unrest, discontent, agitation, strikes, riots, rebellions and wars."

It would no doubt greatly mitigate our troubles were it possible to make at one and the same time all the adjustments necessitated by the upward movement of prices. That, however, cannot be done. As one American writer puts it: "Prices go up in the elevator, while wages have to climb up the stairs."

In a Memorandum issued at the beginning of March last by the Supreme Council of the Peace Conference it is stated that general wholesale prices have advanced since 1913 as follows:—

United States	120 per cent.
Great Britain	170 ,, ,,
France, Italy and Belgium	300 ,, ,,

Economists are practically unanimous in considering that these increases are due mainly to the inflation of money by means of the printing press. A table in Parliamentary Command Paper 434, issued in November last by the British Government at the instance of Lord D'Abernon, showed that the expansion of the currency, taking 1913 as 100, had been—

In the United States (up to May, 1919)	173
In the United Kingdom (August, 1919)	244
In France (June, 1919)	365
In Italy (April, 1919)	440

Very substantial additions have been made to the paper currencies of most of the belligerent countries since Command Paper 434 was compiled. Appendix No. 6, which summarises a detailed statement prepared by Mr. O. P. Austin, Statistician of the National City Bank of New York, shows the amount of paper money in circulation in thirty principal countries of the world at the beginning of the War, in November, 1918, when hostilities ceased, and at the end of last year. Mr. Austin writes: "The most astonishing, not to say alarming, feature of this growth of world paper currency and reduction in the ratio of gold reserve thereto, occurs in the development of the first year following the War." There has been a considerable increase in the paper money of the world since Mr. Austin's table was compiled. Returns up to February 10th are published in the Supreme Economic Council's Bulletion No. 8 and up to the end of March last in "L'Economiste Européen." Extending the table by using these later figures we get the following comparison in millions of pounds sterling:—

NOTES IN CIRCULATION.

	July, 1914.	March, 1920.	Increase, taking the figures of July, 1914 as 100.
	£	£	
Allies	1,009	7,107	704
Central Powers ...	246	5,498	2,235
Total Belligerents	1,255	12,605	1,004
Neutral Countries	240	501	210
Total, 30 Countries	1,495	13,106	877

A great deal can be said to excuse the printing of paper money on a large scale during the War, but it is, as Mr. Austin points out, difficult if not impossible to understand why since the Armistice the Allies should have inflated their paper currences by 37%, and the Central Powers by 117%; and it should be remembered that the figures quoted include none of the £8,000,000,000 of paper money said to have been emitted by the Bolsheviki Government since its establishment in October, 1917. It is estimated that the stock of gold coin and bullion in the world was £2,100,000,000 in June, 1914, as compared with £2,440,000,000 at the beginning of the present year. That is, for every £100 of paper money in circulation (excluding that of the Bolsheviki Government) there was in gold coin and bullion £141 in 1914 and only £19 according to the latest figures.

There are signs, although they are not numerous, that the political leaders of the world are beginning to realise that what Dr. G. Vissering describes as "the practically unbridled increase of circulation media" is the root cause of rising prices.

Mr. Lloyd George, speaking in the House of Commons on February 10th last, said:

> "The right hon. gentleman suggests that the high prices are due to the extortionate profits which have been made by wholesalers and retailers, but it is not even approximately that. I am not going to say that there are no unfair profits. The real explanation of the high cost of living is the devaluation of money. You may put on a percentage to the cost for profit, but it is only a percentage and not a considerable one. The real inflation of prices is due to the fact that money has not got the value which it had before the War. That is a fact not merely in this country, but in every country in the world, and it is right that the working classes of this county should know it. Anybody who says that high prices are due to profiteering either does not know the facts or is misleading the people. There is a good deal, no doubt, that can be done, but there is only one way in which prices can be reduced and that is by increased production. There is no other way."

In the House of Commons, on March 25th last, the Prime Minister emphasised that "high prices could only be remedied by increased production and national economy."

Mr. Lloyd George's diagnosis is sound, but the remedy he prescribes is inadequate. It is the fashion to-day to preach greater economy and more production. That is the popular gospel, but little is being done to create conditions favourable to greater economy and more production. The vast majority of the preachers of these panaceas do not realise that nothing is more likely to discourage economy and production than a variable standard for deferred payments. The greater economy and the additional production that are within the bounds of possibility under existing conditions will not cure or materially diminish troubles which are due chiefly to the excessive issue of paper money. In an address delivered before the Second Pan-American Financial Conference at Washington on January 22nd last Mr. Paul M. Warburg, Chairman, Acceptance Council and Committee on Banking of New York Merchants' Association and former Vice-Governor Federal Reserve Board, said: "In practically all leading countries the people have been urged in the strongest possible manner to produce more and to consume less. I believe it is safe to say that this appeal to voluntary action on the part of the individual has universally failed. Extravagance will not be curbed and the increase in prices will be arrested not by moral suasion, but only through the effective pressure of necessity. If Governments adopt a rigid policy of preventing the further issue of Government securities and money for the purpose of covering current deficiencies, they will take the first and most effective step in combating the decrease of production, the rise of prices, and the fall of exchanges. If they will not—or cannot—adopt such a course, they are headed for insolvency and social and economic disruption."

In an article on "The Unsatisfactory Functioning of the Federal Reserve System Since the Armistice," Professor Sprague, Professor of Banking and Finance, Harvard University, writes:—

> "The Federal Reserve Board . . . has repeatedly urged increased production as a remedy for high prices. In recommending this remedy, the Board disregards all past experience, which is uniformly to the effect that increasing production never brings prices down while business is active and a plentiful supply of credit is available. Strict economy in individual expenditure is also urged by the Reserve Board as an effective remedy for the high cost of living. It would indeed be effective if generally adopted; but here again past experience, and present experience for that matter, is conclusive to the effect that habits of thrift are weakened during periods of rising prices and suddenly increased money incomes." (*The Economic World*, March 20th, 1920.)

Usually the War is held directly responsible for the shortage of raw materials for industrial purposes, paticularly in France, Italy, and Central Europe, and for the decreased production of staple articles generally. A close examination of the position shows that the chief root cause of the trouble is the over-issue of paper money. The outside world is willing and able to supply a considerable quantity of raw material to the starving factories of Europe were it possible to make provision for future payment in something better than paper, the value of which is in every case uncertain, and in most cases rapidly declining.

As to decreased production generally let us glance at the position in England According to the Board of Trade the actual weight of exported British produce and manufactures declined from 91,172,000 tons in 1913 to only 46,104,000 tons in 1919 Why? I venture to suggest that the answer is to be found in the Ministry of Labour's review of conditions in Britain in 1919. There it is stated that during that year British industrial workers lost 34,483,000 working days in trade disputes; and that, further, there were accorded to 6,400,000 workers in the course of the year voluntary reductions of weekly working hours to the amount of 41,461,000 hours a week, or, for a full year 2,155,972,000 working hours. It is, I think, admitted that for the most part these changes were occasioned primarily by labour unrest caused by the rise in prices, which, I submit, was due principally to monetary inflation.

Now let us examine the position of the United States, the largest producer of coal and pig iron. The Swiss Bank Corporation, in their interesting review for 1919, just published, state that as these two industries (coal and pig iron) may be "considered the key stone of the economic structure, it would appear safe to conclude that the actual production in other branches of industry has been on approximately the same level." Here are the United States average monthly production figures in thousands of metric tons for last year, compared with 1918 and 1913:—

	Coal.		Pig Iron.	
	Tons.	Proportionate figures.	Tons.	Proportionate figures.
1913 ...	43,087	100	2,622	100
1918 ..	51,809	120	3,306	126
1919 ..	41,157	96	2,590	99

I think an impartial investigator, conversant with the industrial history of the past two years in the United States, would say without hesitation that the low outputs of coal and pig iron in 1919 were due mainly to labour troubles and that these labour troubles were due almost entirely to the rise in the cost of living brought about by the excessive expansion of the currency. This is true even of the United States, although since June last year their paper money has been convertible into gold which may be exported. At the beginning of 1914 the paper money in circulation in the United States was just over one billion dollars. At the beginning of the present year it was over four billion dollars (page 231, *American Review of Reviews*, March, 1920). The fact is, whichever way we turn we come back to the inflation of the currency as the main stumbling block hindering the recovery of the world from the effects of the Great War.

Theoretically it should be possible to reduce prices and the cost of living by (1) economising, (2) increasing production, and (3) diminishing the quantity of money in circulation. Experience, however, has shown that a stable currency is the condition on which economy and increased production depend and that the instability of prices, which invariably results from the over-issue of inconvertible paper money, encourages extravagance and unrest and militates against production and economy. It is recorded that during the greenback period in the United States, the inclination of the population—except in California—was to abandon the production of solid wealth for more speculative employments. Mr. Hugh McCulloch, Secretary of the United States Treasury, in his report for 1865 said:

> "There are no indications of real and permanent prosperity . . . in the splendid fortunes reported to be made by skilful manipulation at the gold room or the stock board; no evidences of increasing wealth in the facts that railroads and steamboats are crowded with passengers, and hotels with guests; that cities are full to overflowing, and rents and the necessities of life, as well as luxuries, are daily advancing. All these things prove rather . . . that the number of non-producers is increasing and that productive industry is being diminished. There is no fact more manifest than that the plethora of paper money is not only undermining the morals of the people by encouraging waste and extravagance, but is striking at the root of our material prosperity by diminishing labour."

Mr. David A. Wells, who was Special Commissioner of Revenue in the United States from 1866 to 1869, said in one of his reports:—

> "During the last few years large numbers of our population, under the influence and example of high profits realized in trading during the period of monetary expansion, have abandoned employments directly productive of national wealth, and sought employments connected with commerce, trading, or speculation. As a consequence we everywhere find large additions to the population of our commercial cities, an increase in the number and cost of the buildings devoted to banking, brokerage, insurance, commission business, and agencies of all kinds, the spirit of trading and speculating pervading the whole community, as distinguished from the spirit of production."

In a word, the main lesson which the experience of the United States with its greenbacks teaches is that the establishment of a sound currency is the first step on the road to prosperity, and that in order to achieve greater economy and more production we must begin by securing a stable monetary standard. And it is impossible to secure this whilst the inflation of the currency by means of the printing press is forcing up prices.

Why is there a premium on gold? An ounce of gold can never be worth more than an ounce of gold. No one will be so foolish as to give five pounds in gold for four pounds in gold. There is a premium on gold simply because the currency in which the premium is paid is depreciated as compared with gold. It is depreciated because the paper money which has been substituted for gold is not convertible into gold on demand and has been issued in excessive quantities. In pre-war days the exchange rates between countries on a gold standard varied only to the extent of the cost of sending gold from one country to another. Now, as between two countries where one or both have placed an embargo on the exportation of gold the rates of exchange depend on the relative level of prices in the two countries, having due regard to the cost of transport, insurance, Customs duty, and any additional handling that may be necessitated; and the level of prices is determined by the degree of currency inflation in each country. With a free gold market, the general level of prices tends to become uniform throughout the world, after allowing, of course, for the factors mentioned. The currency position of England to-day differs only in degree from that with which Ricardo and the Bullion Committee had to deal, and the principles which they enunciated are applicable to the present situation. They held that—

> "So long as the currency of any particular country consists exclusively of gold and silver coins, or of paper immediately convertible into such coins, its value can neither rise above, nor fall below, the value of the metallic currencies of other countries, by a greater sum than will suffice to defray the expense of importing foreign coin or bullion, if the currency be deficient; or of exporting a portion of the existing supply, if it be redundant. But when a country issues inconvertible paper notes, they cannot be exported to other countries in event of their becoming redundant at home; and whenever, under such circumstances, the exchange with foreign States is depressed below, or the price of bullion rises above, its Mint price, more than the cost of sending bullion abroad, it shows conclusively that too much paper has been issued and that its value is depreciated from excess" (page 236, Economic Annals of the Nineteenth Century, 1801-1820, by Professor Smart).

How long will the premium on gold last? It is impossible to answer this question with any degree of certainty. From the attached statements (Appendices 3 and 4) it will be seen that the premium on gold in England at the beginning of the nineteenth century and in the United States during and after the Civil War lasted for a considerable number of years. It is obvious that the premium on gold will last in some form or another so long as there is in England a redundance of paper money and an embargo on the export of gold. It is also obvious that England cannot revert to a free gold market in a short time. The total liabilities of the Government and the banks in the United Kingdom on account of paper money and bank deposits have increased from about one thousand million pounds in 1913 to about two thousand five hundred million pounds at the beginning of this year, whilst there has been hardly any change in the quantity of gold held by the Government and the banks. Were the embargo removed now everybody would want to exchange their notes for gold and to withdraw their deposits in gold in order to be able to take advantage of the premium. Under these circumstances, it seems certain than the sudden removal of the embargo on the export of gold would lead to a financial crisis—probably the worst the world has ever seen.

In South Africa there has also been an undue, and, in my opinion an unnecessary, expansion of paper money and deposit liabilities (see Appendix 5), which now renders it advisable to avoid a sudden removal of the embargo on the export of gold. Unfortunately, the policy pursued by the banks in South Africa, particularly since the embargo was placed on the export of gold in August, 1917, has forced up the general level of prices in this country and substantially increased the working costs of the mines. The gold producers of the Transvaal and Rhodesia may lose the benefits obtainable from the premium on gold in one of two ways:

> (1) The value of British currency may be improved as compared with our currency and with gold; in other words, the general level of prices in England may fall.

or,

> (2) The South African currency may be depreciated to the level of Bradburys. That is, the general level of prices in South Africa may be raised to that which prevails in England.

The second course constitutes by far the gravest immediate danger as far as the gold mining industry is concerned. The inflation of the local currency which has been taking place at considerable speed in recent months is increasing prices rapidly and will, if not arrested in time, add to the working costs an amount greater than the total premium. It will be seen from Appendix 5 that the South African banks have increased their note issue from £2,150 000 in June, 1914, to £9,285,000 at the end of March last, and that in the same period their deposits have been increased from £33,305,000 to £95,000,000. Taking the 1914 figures as a basis, the increases have been from 100 to 432 for notes and from 100 to 285 for deposits. The amount of gold coin and bullion in the possession of the banks has remained almost stationary, but the ratio to notes and deposits has decreased from 19·5 per cent. in 1914 to 6·7 per cent. at the end of March last. Prior to the outbreak of the War the banks had to have in hand a sufficient supply of gold to meet demands for export and this compelled them to keep their notes and deposit liabilities within safe limits. When War broke out the presence of German men-of-war on the high seas made it dangerous to export gold from South Africa, and as a result the banks were enabled to add considerably to their uncovered liabilities without much risk. In August, 1917, an embargo was placed on the export of gold and this entirely relieved the banks of any liability as far as the provision of gold for export was concerned and enabled them to go on issuing practically as many uncovered notes as they liked. In fact, the prohibition of the export of gold encouraged inflation at the very time when it should have been discouraged, as the necessity for the embargo was itself conclusive proof that an over-issue of paper money had already taken place. In justice to the Union Government it should be stated that the United States and Japan also prohibited the exportation of gold about the same time as this was done in South Africa. It is, of course, easy to be wise after the event, but it is much to be regretted that the Union Government did not from the outset impose such conditions as would have prevented an excessive issue of notes.

The expansion of the paper money in circulation in South Africa has taken place approximately as follows:

	Amount Issued.	
Prior to 30th June, 1914	£2,150,000	23
During the War ...	4,000,000	43
From the date of the Armistice up to March last	3,135,000	34
Total	£9,285,000	100

I may add that of the total amount in circulation at the end of March 25 %, or £2,285,000, was issued after the holding of the Pretoria Gold Conference in October last. The policy of monetary inflation pursued in South Africa since 1914 has been suicidal from every point of view. If the South African banks are allowed to continue this policy the time cannot be far distant when more than half the gold mines of the Rand will be compelled to suspend operations owing to increases in costs, and when the coal producers of South Africa will find it impossible to compete with American coal in the markets of the world.

No doubt South Africa has to suffer to some extent for the sins of other countries, but the experience of California during the Civil War (to which I shall refer later) shows that currency inflation elsewhere would have caused us little or no embarrassment had we from the outset abstained from inflating our own currency. We have, of course, also to recognise that gold itself, when measured in commodities, has undoubtedly depreciated in value in consequence of its widespread supersession by paper. This is proved by the general level of prices in the United States, which is on a gold standard and has a free gold market. The Federal Reserve Bank system, established in 1914, has been an important factor in depreciating the value of gold in the United States as it has enabled the fullest possible reasonably safe use to be made of paper money.

It remains for me to add a few words as to past experiments with inconvertible notes. In October last the editor of the *Momento Economico* of Milan, having shown that the then circulation of paper money in Europe was ten times the pre-war amount, expressed the opinion that there were only two ways to deal with the inflation, either to let things find their own level, as was the case in the United States after the War of Secession, or " deliberately to write down the nominal value of the notes as was done in the last 120 years twice in France, twice in Russia, three times by Austria-Hungary, and several times by the smaller States of Latin America."

In the past, oftener than not, the issuers of inconvertible notes have defaulted, either entirely or partially. In 1789 the revolutionary Government of France issued legal tender notes called assignats on the security of the lands confiscated from the clergy. By 1796 assignats had fallen in value so that 100 francs were not worth 3d. They were replaced by mandats, which also rapidly depreciated, and eventually became worthless. Napoleon I., when he came to direct the destinies of France, declined to have anything whatever to do with paper money. In a circular dated October 25th, 1810, M. de Montalivet, speaking in the name of Napoleon I., referred to paper money as "the greatest curse of nations; it is in the moral sphere what the plague is in the physical."

In 1775 the Continental Congress of the United States issued inconvertible notes, which shortly after the Declaration of Independence were increased to 240,000,000 dollars. They fell rapidly in value, and by 1781 they were worthless, giving rise to the expression, "not worth a Continental."

There are two notable historical instances of the re-establishment on a gold basis of inconvertible notes which had been depreciated for some years, namely,—

(1) The Bank of England notes issued in the United Kingdom under the Bank Restriction Act of 1797 and which—except for a short interval in 1816—remained inconvertible into gold until 1821 (Appendix 3);

(2) The forced paper currency, known as Greenbacks (because of the colour of the ink with which the reverse side was printed) issued by the United States Government in 1862 and which only became legally redeemable in gold on January 1st, 1879 (Appendix 4).

The Bank Restriction Act of 1797 prohibited the Bank of England from paying specie for its notes. For a time there was little divergence between the Mint price of gold and the market price in bank notes. But as will be seen from Appendix 3, gold began to sell at a premium in 1801 and was at a considerable premium from 1810 to 1816. I have already referred to the Bullion Committee which reported in 1810. Its recommendations were brought before the House of Commons in 1811 and rejected by an overwhelming majority, owing chiefly to the influence of the directors of the Bank of England. The controversy continued, and by 1819 the House of Commons and the commercial world generally had come to recognise the soundness of the theories of the Bullion Committee. The directors of the Bank of England still denied that the issue of bank notes had any effect on foreign exchanges, or on the price of gold, and they argued that there could be no over-issue of notes made in order to discount sound mercantile bills. They actually passed a resolution disputing the soundness of the principles embodied in the Bullion Committee's report, a resolution which they solemnly expunged from their records in 1827. On February 3rd, 1819, the two Houses of Parliament each appointed a Committee to enquire into the position of the Bank of England. There was at the time a considerable body of opinion in favour of effecting the resumption of cash payments by reducing the quantity of gold in the pound sterling instead of raising the gold value of the depreciated paper. It was held that to alter the standard would involve less injustice than the adoption of measures involving a heavy fall in prices. The two Committees entirely concurred in the conclusions of the Bullion Committee and recommended that after February 1st, 1820 the Bank of England should be required to deliver gold of standard fineness in quantity not less than sixty ounces at £4 1s. an ounce; that after October 1st, 1820, the rate should be reduced to £3 19s. 6d., and after May 1st, 1821, to the Mint price of gold, namely, £3 17s. 10½d. This obligation to pay in bullion was to continue for not less than two and not more than three years after May 1st, 1821, when cash payments should be resumed. It was also recommended that all laws prohibiting the melting and the exportation of coin should be repealed. A Bill embodying the recommendations of the two Committees was passed by Parliament and the Bank resumed cash payments in 1821.

The other notable instance of the re-establishment on a gold basis of an inconvertible paper, that of the Greenbacks, is particularly interesting to us on account of the high premium (measured in Greenbacks) which the gold producers of the United States obtained for many years, and the fact that California and the Western States, where the gold was produced, adhered strictly to the gold standard throughout the whole period. During the Civil War (1861-1865) both sides resorted to paper money. That of the Confederate States eventually became worthless. That of the North, the Greenbacks, after violent and extreme fluctuations for many years, was restored to parity with gold on January 1st, 1879 (see Appendix 4). The Greenbacks were first issued in 1862. They soon depreciated in terms of gold, and by June, 1864 100 cents in gold sold in New York for 280 cents in paper money. The introduction of the Greenbacks as legal tender money threw the whole monetary system of the United States into disorder except as regards the Far Western States where business transactions continued to be carried on in gold. Mr. D. A. Wells, writing in 1887, stated:

> "The State Legislature of California passed an Act, in deference to an almost universal public sentiment, making it obligatory upon the State Courts to give judgments payable in United States gold coin, and for sheriffs and constables to collect such judgments in such coin, when the contracting parties had not covenanted and specified for other forms of payment. Greenbacks were brought into the State and used for the payment of postage and in other transactions in which the Federal Government was a party; but for all other purposes, although under the supreme law of the land, they were legal tender for all debts, their use was odious, and a man who tendered anything but gold in payment of his daily purchases, or in the discharge of his time contracts, was regarded as dishonourable. And this state of things continued during the entire period of the War, and until the resumption of specie payments by the Federal Government in 1879, when the prejudice against the use of the greenbacks and the national bank currency gradually disappeared, although the larger portion of the payments by the banks of California are still made in gold coin. The same state of things existing in California was also characteristic of all the other portions of the Pacific Coast embraced in the territory of the United States. The common currency is also mainly gold and silver at present, as the old prejudice against the Greenback still seems to be influential." (pp. 93, 94 Appendix 5, Report Royal Commission on Gold and Silver 1888, C.—5512.—I.)

As the result of their adherence to the gold standard the States on the Pacific Coast did not suffer from the violent price fluctuations which caused much trouble in the rest of the United States, the cost of mining did not go up, and generally their people remained prosperous practically throughout the Greenback period, a proof of which is the fact that they nearly trebled in number between 1860 and 1880.

I must conclude now. There are many points with which I should have liked to deal, but this Paper is already too long. It seems to me difficult to exaggerate the stupendous character of the work which has to be accomplished in order to re-establish on a sound monetary basis a world flooded with inconvertible paper.

As to what the Governments of the world should do to remedy the present deplorable state of affairs, I know of no better plan than that contained in a statement recently published by Dr. G. Vissering, the President of the Netherlands Bank. As a first step Dr. Vissering recommends—

> "At their own initiative and relying on their own efforts, each country individually should take steps to make an end of the senseless creation of artificial buying power; this must be done before any other reconstructive act, because such reconstruction is absolutely unachievable if this evil is not primarily suppressed."

General Francis A. Walker, who lived through the Greenback period in the United States, and whose work on Money is still one of the best text books on the subject in the English language, records in the following striking words his mature conviction as the result of a quarter of a century of close study of inconvertible paper money:

> "Let me say that it is my firm belief that the issue of inconvertible paper money is never a sound measure of finance, no matter what the stress of the national exigencies may be. I believe it to be as surely a mistaken policy as the resort of an athlete to the brandy bottle.

It means mischief always. If there is ever a time when a nation needs its full collected vigour, with a steady pulse, a calm outlook, a hand and a brain undisturbed by the fumes of this alcohol of commerce—paper money—it is when called to do battle for its life with superior force. It is to my mind the highest proof ever afforded of the supreme intellectual greatness of Napoleon, that during twenty years of continuous war, single-handed against half the powers of Europe, he never was once driven to this desperate and delusive resort." (Brief Political Economy, page 137.)

APPENDICES.

(1) The Cost per Ounce of Gold Production in the Transvaal.
(2) The Exchange Value of Commodities in the United Kingdom in 1919 compared with 1913.
(3) Variations in the Market Price of Gold Bullion in London, 1800-1821.
(4) United States Greenbacks, 1862-1877.
(5) The Currency Position of South Africa, 1914-1920.
(6) The Paper Money and Gold Reserves of Thirty Principal Countries of the World in 1914, 1918 and 1919.

APPENDIX 1.

COST PER OUNCE OF GOLD PRODUCTION IN THE TRANSVAAL, 1888—1919.

Year.	Yield.		Dividends.	Costs. (Difference between Dividends and Value of Yield.)		
	Fine Ounces.	Value.		Amount.	Per Oz.	Variation in Costs taking the average cost of 1888 to 1914 as 100.
		£	£	£	£ s. d.	
1888	227,749	967,116	127,352	840,064	3 13 9	115·5
1889 1893	3,838,776	16,324,087	3,133,381	13,190,706	3 8 9	107·6
1894 1898	12,414,838	52,734,883	13,642,958	39,091,925	3 3 0	98·6
1899 1902	5,963,427	25,331,019	5,788,505	19,542,514	3 5 6	102·7
1903 1907	23,899,518	101,518,708	25,007,329	76,511,379	3 4 0	100·3
1908 1912	39,235,455	166,661,623	43,817,772	122,843,851	3 2 7	98·1
1913	8,798,336	37,372,949	8,596,532	28,776,417	3 5 5	102·5
1914	8,394,322	35,656,814	8,401,060	27,252,754	3 4 11	101·7
1888 1914	102,772,421	436,567,199	108,517,889	328,049,610	3 3 10	100·0
1915	9,093,902	38,628,137	7,824,799	30,803,638	3 7 9	106·1
1916	9,296,618	39,489,522	7,271,589	32,217,933	3 4	108·6
1917	9,018,084	38,306,381	6,718,604	31,587,777	3 10 1	109·7
1918	8,418,292	35,758,636	5,273,633	30,485,003	3 12 5	113·4
1919	8,331,294	39,516,51[illegible]*	6,075,765	33,440,747	4 0 3	125·7
	146,930,611	628,266,987*	141,682,279	486,584,708	3 6 3	103·7

*Including Premium on Gold.

APPENDIX 2.

EXCHANGE VALUE OF COMMODITIES IN THE UNITED KINGDOM IN 1919 COMPARED WITH 1913.

(This table is constructed in order to show what the position of each Group of Producers would be supposing money were eliminated and that commodities were exchanged for commodities).

Groups.	Variations in Exchange Values in 1919 compared with 1913 on the basis of								
	CURRENCY.	BARTER. Number of units of its own products which each group would have had to give in 1919 in order to acquire 100 units of the products of each of the other groups							
	Board of Trade Index numbers of prices in 1919 taking 1913 as 100.	Group I Metals and Minerals	Group II. Textile Raw Materials	Group IIIa. Corn, Grain, etc.	Group IIIb. Meat. Fish and Dairy Products.	Group IIIc. Colonial Products and Tobacco.	Group IIId. Bevera-ges.	Total. Group III.	Group IV. Sundry Materials
I. Metals and Minerals ...	302	100·0	109·2	124·5	132·3	113·2	131·2	127·2	104·4
II. Textile, Raw Materials	276·6	91·6	100·0	114·1	121 0	103·8	120·2	116·5	95·6
IIIa. Corn, Grain, etc. ...	242·5	80·3	87·7	100·0	106·1	91·0	105·3	102·1	83 8
IIIb. Meat, Fish and Dairy Products	228·5	75·7	82·6	94·2	100·0	85·7	99 3	96·3	79·0
IIIc. Colonial Produce and Tobacco	266·6	88·3	96·4	109·9	116·7	100·0	115 8	112 3	92·2
IId. Beverages	230·2	76·2	83·2	94·9	100·7	86·3	100·0	97 0	79·6
III. Group III, Total ...	237·4	78·6	85·8	97 9	103·9	89·0	103·1	100·0	82·1
IV. Sundry Materials ...	289·2	95 8	104·6	119·3	126 6	108·5	125·6	121·8	100·0
Averages	254.3	84·2	91·9	104·9	111·3	95·4	110·5	107·1	87·9
Difference in exchange values in 1919 compared with 1913 measured in CURRENCY:	—	—	—	—	—	—	—	—	—
Average increase per cent. ...	154·3	—	—	—	—	—	—	—	—
COMMODITIES:									
Average increase per cent. ...	—	15·8	8·1	—	—	4·6	—	—	12·1
Average decrease per cent. ...	—	—	—	4·9	11·3	—	10·5	7·1	—

Alexander Baring (afterwards first Lord Ashburton) said in reference to the difficulties caused by the contraction of the currency in 1819: "An alteration in the value of currency is what few, even the wisest, generally perceive. They talk of an alteration of the price of bread, and provisions, never reflecting that the alteration is not in the value of these articles, but in that of the currency in which they are paid"

APPENDIX 3.

VARIATIONS IN THE MARKET PRICE OF GOLD BULLION IN LONDON FROM 1800 TO 1821.

		Market Price per oz. Standard.			Premium.
		£	s.	d.	%
1800	...	3	17	10½	0·0
1801	...	4	5	0	9·1
1802	...	4	4	0	7·9
1803 to 1808	...	4	0	0	2·7
1809	...	4	10	0	15·6
1810	...	4	10	9	16·5
1811	...	4	17	1	24·7
1812	..	5	8	0	38·7
1813	...	5	10	0	41·25
1814	...	5	4	0	33·5
1815 Highest	...	5	7	0	37·4
Lowest	...	4	3	0	6·6
1816 Highest	...	4	2	0	5·2
Lowest	...	3	18	6	0·8
1817 Highest	...	4	0	0	2·7
Lowest	...	3	18	6	0·8
1818 Highest	...	4	2	6	5·9
Lowest	...	4	0	6	3·4
1819 Highest	...	4	3	0	6·6
Lowest	...	3	17	10½	0.0
1820	...	3	19	11	2·6
1821	...	3	17	10½	0·0

The above figures are based on tables published by Thomas Tooke, Sir Henry Parnell, R. Mushet and Sir James Graham. Professor Andréadés, in his "History of the Bank of England," gives slightly different figures. He states:—"On May 1st, 1821, the paper currency, established since 1797, was replaced by a currency on a metallic basis, of which the country had been deprived for twenty-four years and two months. During this period the crisis had at times been very intense, and the scarcity of coin had caused a depreciation in the notes issued by the Bank. This depreciation, from being £8 7s. per £100 in 1801, had varied in the following manner:—

£7 5s. in 1802,
£2 3s. from 1803 to 1809,
£13 9s. in 1810,
£7 16s. in 1811,
£20 14s. in 1812,
£22 18s. in 1813,
£25 3s. in 1814,
£19 14s. in 1815,
£16 14s. in 1816,
£2 13s. from 1817 to 1818,
£4 9s. in 1819,
£2 12s. in 1820.

The depreciation continued until 1821, at which date the notes once more circulated at par."

APPENDIX 5.

CURRENCY POSITION IN SOUTH AFRICA.

1914-1920.

(000 omitted.)

	June 30th, 1914.	March 31st, 1920.	Increase taking figures of 30th June, 1914 as 100.
Notes issued by South African Banks ...	2,150	9,285	432
Deposits of South African Banks	33,305	95,000	285
Gold Coin and Bullion in possession of the Banks in South Africa ...	6,913	6,945	100·4

This table does not show the extent to which the total currency of South Africa has been inflated. To arrive at that figure it is necessary to know the metallic circulation of South Africa on June 30th 1914, and on March 31st, 1920.

Of the £95,000,000 deposits £58,000,000 are payable on demand.

APPENDIX 4.

UNITED STATES GREENBACKS, 1862—1877.

Highest and Lowest Premium Rates on Gold by Months from January, 1862 to December, 1866.

	1862		1863		1864		1865		1866	
	L	H	L	H	L	H	L	H	L	H
	%	%	%	%	%	%	%	%	%	%
January	0	5	34	60¾	51½	60	97½	134½	36¾	44⅝
February	2⅛	4¾	53	72½	57⅛	61	96⅜	116¾	35⅞	41¼
March	1⅛	2½	39	71¾	59	69¾	48⅛	101	25	36⅛
April	1½	2¼	46	59	66¼	87	44	60	25	29½
May	2⅛	4⅛	43½	55	68	90	28⅝	45¼	25½	41½
June	3½	9½	40½	48⅞	89	151	35¾	47⅝	37⅝	67¾
July	9	20⅛	23¼	45	122	185	38	46½	48¼	55¾
August	12½	16¼	22⅛	29¾	131½	162	40⅛	45⅝	46½	52¼
September	16½	24	27	43⅛	85	155	42⅝	45	44	46¾
October	22	37	40⅜	56¾	89	129	44	49	45⅝	54¾
November	29	33¼	43	54	109	160	45½	48¾	37½	48[illegible]
December	30	34	47	52¾	111	144	44½	46¾	31¼	41¾

The Premium on Gold continued until 1878 and averaged in :

1867	38%
1868	43%
1869	37%
1870	16%
1871	12%
1872	15%
1873	14%
1874	10%
1875	15%
1876	12%
1877	5%

APPENDIX 6.

THE PAPER MONEY AND GOLD RESERVES OF THIRTY PRINCIPAL COUNTRIES OF THE WORLD IN 1914, 1918, AND 1919.

Summary of a Statement prepared by Mr. O. P. Austin, Statistician of the National City Bank, New York, and published in the January, 1920, Number of *The Americas.*

(The conversion into £'s has been done on the normal pre-war values. 000,000 are omitted.)

Allies—		July, 1914	November, 1918.	December, 1919.
Excluding Bolshevik Russia ...	Notes	£1,009	£5,133	£6,067
	Gold	773	1,072	1,012
	% Gold	76·6	20·9	17·2
Central Powers	Notes	246	2,529	3,872
	Gold	122	141	67
	% Gold	49·7	5·6	1·7
Total Belligerents	Notes	1,255	7,662	9,939
	Gold	895	1,213	1,109
	% Gold	71·3	15·8	11·2
Neutrals	Notes	240	465	497
	Gold	106	282	298
	% Gold	44·3	60·6	59·9
Total, 30 Countries	Notes	1,495	8,127	10,436
	Gold	1,001	1,495	1,407
	Gold	70·0	18·4	13·7

Recent figures show that there has been in several countries a considerable increase in the issue of paper money since this table was compiled. For instance, Mr. Austin gives the paper money in circulation in Germany at £1,600 millions, whilst, according to a communication from Geneva, published in the New York *Evening Post* of February 7th last, the total circulation of paper money in Germany exceeded fifty billion marks (about £2,500,000,000 at the pre-war rate) of which more than one-third (17,000 million marks) was issued in 1919. The correspondent of the *Evening Post* adds: "In view of this inflation it is no wonder that no stability in the value of labour and commodities can be achieved in Germany."

Mr. A. Aiken (*Hon. Life Member*): It is a very pleasing duty for me to be able to say the few words I should like to say in praise of Mr. Evans's paper. I, for one, do not propose to criticise it; as a matter of fact, he has left me very little room to criticise it. Part of the paper, one would think, goes to show an extraordinary difference of opinion on many points of economics, especially on currency matters; but if you notice carefully all through the paper, they are all economists on the one side and they are all politicians on the other. There are various descriptions of politicians. I leave you to adopt your own. But I want to say Mr. Evans is on the side of the economists, and, I hope, so am I. It is true that in lots of economic theories you will find differences of opinion on little matters; for instance, I do not agree with Mr. Evans in every respect; he says he is a subscriber to the quantity theory of gold. I say I am not. But if I am going to accept Mr. Evans's definition of the quantity theory, I am quite in accord with him. Mr. Evans' statement really means this, that gold, like any other commodity, must vary in value with its quantity in relation to the demand or the necessity for it. Now, there is no difference between gold and any other article in that respect; and, if that is what Mr. Evans calls the quantity theory so am I an exponent of that theory, too.

Mr. Evans's friend, Prov. Irving Fisher, goes a long way further. I would just like to remind Mr. Evans of that fact. He can look it up.

One of the most valuable features of the paper, however, is the wonderful wealth of testimony he has dug up, with big names attached to it. I hope he will induce people to realise what they do not to-day, namely, that all these troubles from which we are suffering have existed in the world at different times before—and that they have been solved, and solved only in certain ways; the experience of the past is what these writers on economics have taken as the basis of their theories. These theories have stood the test of experience, and, if we adopt them to-day, I have no doubt we shall come through all right; but, if we go on drifting as we are doing, not only here but elsewhere, then, I tell you, we are laying up more and more trouble, and it may become insuperable in the end.

I have a very great admiration for Mr. Evans's paper; and he will be a bold man that attacks him.

There are one or two remarks I would like to make, certainly not by way of criticism, but more as an addition to what Mr. Evans has said. One point is this. Lots of people here will not believe that our currency is depreciated. They say, "Yes; it is quite true currency in England has depreciated." They know that, because the English people themselves admit it, but they do not believe South African currency has depreciated, and they quote the fact that you can go into a bank in Johannesburg and present notes, or present a cheque, and demand gold and get it. They say, "How can our currency have depreciated when you can get gold for it on demand?"

Mr. Evans has not dealt altogether very fully with every point; he could not do so unless he wrote a book instead of merely a paper. He has not told you that after you have got the gold from the banks you can do nothing with it, except pay it away again. You cannot export it, and therefore you do not know to-day what is the extent of depreciation in South African currency. One thing is certain, it has depreciated, and for this reason. You find, if you sell raw gold and convert it, you get more than a hundred pounds to your credit after you have sold what was £100 worth of gold before the war; that surely shows that what you are getting paid, whether by way of bank credit or notes, has certainly depreciated. The extent of that depreciation it is impossible to-day to measure. What you get back for the raw gold would show that the currency has probably depreciated about 17½ per cent., more than less. I deduce that from the fact that with gold selling to-day in England at £5 8s. 6d. per fine oz., if you take 8¼% off for exchange, the proceeds are brought to about practically a fiver, and, if you compare that with what fine gold is worth in sovereigns, namely, about £4 5s., you get a depreciation in your currency of about 17½%. But no one can say that is the real measure of depreciation, or indeed any certain measure at all. It is absolutely arbitrary, because it is based on the exchange rate which the banks have fixed between here and London; and that is only, to my mind, a mere essay in attempting to meet the position. In all probability, indeed the only way that you can ascertain what the actual depreciation is would be if you at once removed the embargo on gold and the banks managed to keep from shutting their doors—I do not know how they could—but perhaps they could do it if they were given a moratorium under which they need not pay their notes or their deposits in gold.

The depreciation might be a good deal more. Nobody can tell you. Consequently this, I think, is a remarkable illustration of the absolute uncertainty of living with an inconvertible paper currency—to base all your transactions upon it. It is bound to land you in difficulty you can never foresee. Nobody foresaw what was going to happen when the Government in 1917 put an embargo on the free flow of gold. It is quite clear now that was a huge mistake, and, as a matter of fact, if it had not been done, I have no doubt myself the prices here to-day would have been a good deal lower, that business would have been ever so much sounder and that we would not have had the troubles to face and clean up that we have to-day.

I began by remarking that many people will not believe that South African currency is depreciated, although they are quite willing to believe other currencies are. I do not know whether I made my point clear? But the whole point is this. Owing to the embargo on the free flow of gold we get more for our raw gold in South African currency than the par value. Therefore the currency has depreciated.

Another point which is very often made is this. They say, "Why bother about making a big exchange rate between here and London? All that we need to deal with is the difference between what we have got to pay and what has to be paid to us by our debtors or creditors abroad." Now, that is another fallacy which, I think, can be easily shown up. You can never clean up your own currency unless you get on to a metallic basis; that is to say, make your currency either gold or its equivalent. There is only one way to make it the equivalent of gold; that is to insist that whatever paper substitute you have for gold has got to be redeemed on demand at par without any hesitation and without any qualification. That is the only condition I am aware of in history that has ever kept a currency sound. Now, if you tried to do that and to keep a low rate of exchange—supposing you tried to stick to the 8¼ % exchange rate between here and London and remove your embargo on the free flow gold here, and you got a few millions of gold into this country in order to clean up your currency, what would happen? You would find clever people converting their balance into gold and sending that gold out of this country and getting it back at the 8¼ % discount. Having secured their 25 % to 30 % premium on the sale of the gold they could easily afford the 8¼, and they could go on doing that as long as the banks choose to import the gold for them to deal with. That shows quite clearly that neither the Rothschilds nor any other House in the wide world could ever stand the drain that would be imposed on them: but what will stop it is if, when you withdraw the embargo you at the same time insist on the banks redeeming their bank notes in gold on demand and paying out their deposits also in gold on demand; both things are necessary. If you insist on that, then there is no difficulty and no drain, and all this talk about the hoarding of gold and the disappearance of gold towards the East or anywhere else, ends. You do not find America complaining about people smuggling gold. Why? Because the American paper dollar can be converted any day of the week into a gold dollar. It simply means this. Anyone buying gold from America pays full price for it. Here you can buy gold. I do not know what you can legally do with it, but you can buy it for less than its value. Consequently it is bound to be smuggled, if it is possible at all.

I hope you will join with me in expressing your appreciation of Mr. Evans's most valuable paper.

Mr. H. Newhouse (*Visitor*): I consider it a great privilege to have been invited to attend your meeting to-night and to speak on what is to me one of the most interesting of subjects. I thank you most heartily and will, in return, endeavour to be as brief as the subject and the importance of Mr. Evans' paper permits. I do not propose to comment on Mr. Evans' exposition of the Quantity Theory of Money. I would only congratulate him on the vast research he has used to place before you a series of admirable quotations. I do not challenge them at all, but would remind him that it would not be difficult to collect a similar series of extracts from a large number of authoritative authors, all drawing attention to the need for caution in applying the theory. I will only make two quotations—one from Sir D. Barbour's "The Standard of Value." Sir David, Mr. Evans will admit, is one of the most fervent exponents of the quantity theory, and states it as follows:—"Other things being equal, the level of prices is proportionate to the quantity of money." Later, on p. 55, he says—

"The condition, 'other things being equal,' is very important, and all that we are entitled to say beforehand is that an increase in the Quantity of Money exercises an influence in the direction of lowering its value in exchange for commodities, that an increase in the Quantity of Commodities exercises an influence in the direction of raising the value of money in exchange for commodities, that a diminution in either case has the opposite effect, and that the change will always be proportionate to the increase or decrease in quantity 'if other things are equal,' it being recognised that in practical life other things never are equal, and that the question whether there is an increase or decrease in the Purchasing Power of Money at any particular time must be decided by examination of the facts.

And again—p. 72—"I admit that other things never are equal, and that they are so subtle in their mode of operation that hitherto it has been impossible to say beforehand what the precise effect will be on prices of an increase or decrease in the Quantity of Money or of additional or reduced demands for it. An increase in the Quantity of Money might be followed by a fall in prices; a decrease in quantity might conceivably be accompanied by a rise in prices. Moreover, the price of every commodity is always rising or falling from causes unconnected with the Standard of Value, and it is difficult to trace the effect of the Quantity of Money on prices, unless we examine the changes in price over a long series of years."

The other is from an account I have found of the silver mines of ancient Greece. Our old friend, Xenophon, having finished his career as a soldier, sat down to boost his native land, and says, "It is plain the mines can never be exhausted, nor can silver ever lose its value." Alas! the Macedonians conquered Persia, and the mines stopped working, for this "brought such a vast quantity of silver into Greece, and consequently made labour so dear that the silver found in the mines would, in all probability, scarce counteract the expenses of working them"! So says Xenophon's translator writing in 1657.

I cannot find a clearer and terser statement of the effects of an excess of metallic currency. It remained for an infinitely greater commercial nation to re-prove its truth in our day. I refer to the present experience of the U.S.A., which is, I think, the greatest economic surprise of the war. All the extracts Mr. Evans quotes referring to the evils of a superabundant currency had in mind, I think, their occurrence through the issue of inconvertible paper currency. We now see that the same evils can be the consequence of an excess of gold and can arise in a country enjoying an absolutely free gold market. As Mr. Evans says towards the end of his paper, there has been a great depreciation in the value of gold. The problem before the world, if prices are to be reduced to what I may call a reasonable level, has, therefore, to be solved in two stages. Firstly, the rise in prices due to the depreciation of paper as compared with gold has to be recovered and then the depreciation in the value of gold itself has to be reduced. And the latter rise is the more serious of the two in the United Kingdom, for, assuming paper to be at a discount of 20%, and prices to have risen to 270%, as compared with pre-war days, the restoration of gold prices, assuming these not to go down during the process of restoring currency to a gold level, would still leave prices at 216%.

Now to the subject matter proper of the paper—the gold premium, or, as I would prefer to call it, the premium on gold.

This alteration brings me at once to the root of the question. For the first time in the history of our fields, we are selling our gold not for gold but for pieces of paper, each of which while stamped £1 is not worth one golden sovereign. In other words, the paper is depreciated as against gold, and so long as this state of affairs lasts and so long as we are content to take payment in this medium, so long shall we get a premium. How long will this be? Mr. Evans says it is impossible to say. I quite agree; but I think it may be worth while speculating on the point. In the first place, it may be suggested that there is not a free market in gold bullion in London. Export is only permissible under licence and totally forbidden to a very important consumer—India. In Napoleonic times, while the currency was frankly inconvertible, the bullion market was open. If the same state of affairs ruled to-day as did 100 years ago, we should know the true If the same state of affairs ruled to-day as did 100 years ago, we should know the true price of gold in paper. Probably it would be higher than it is. And we should know where we are as regards the extent of the depreciation of U.K. currency. Incidentally it is curious to observe that it does not pay an U.S.A. creditor to buy gold in England rather than dollar bills—a strong indication that at the moment the balance of trade as between U.S.A. and England is not against England. But let it be assumed that the present premium on gold in the U.K. of say, 25%, is the true measure of depreciation of U.K. currency. This is equivalent to U.K. notes being at a discount of 20%. Hence, when prices fall 20% in the U.K., the premium will disappear—provided that the U.S.A. remains on a gold basis and prices in that country remain stationary. But the U.S.A. is suffering from gold inflation and in that country, as in the U.K., a definite policy of deflation has been adopted. In both countries, the brake has to be applied gradually—a sudden application would have the same effect on the country's trade as similar action on a fast-moving train—disaster. But the process is proceeding. This is seen by the falling prices of some of the more important raw materials, such as copper, tin, lead, silver and wool. The recent rise in coal in U.K. is not, I think, a point against me—it is not a rise in cost of production; it is, it seems, a transfer of a portion of the cost from one set of shoulders to another. There is also ground for the belief that production is increasing. Now, production must increase and deflation decrease more rapidly in the U.K. than in the U.S.A.—taking the latter to be representative of gold countries—if the premium is to disappear. It is also possible for inflation on a gold basis to force prices up to the relative U.K. level—if the process of deflation should be stopped in the U.S.A. In that case, the premium would also disappear and prices remain unaltered. We, therefore, arrive at the conclusion that the premium on gold in the U.K. is due not to inflation in the U.K., but to an excess of inflation as compared with countries having a true gold currency. Now we know that the U.K. is making the most serious efforts both to increase production and to reduce the volume of her paper currency. It is very difficult to judge whether the U.S.A.—the chief of the gold countries—is acting equally strenuously. If she is not, I believe that the general price level will, allowing for duties, cost of transport, etc., soon be similar in the two countries, and, therefore, that the premium on gold will be reduced to vanishing point within a comparatively short time. I do not know whether in this connection the fact that 100 years ago it lasted over twenty years is a guide to the probable length of its duration this time; but certainly the length of its duration after the American Civil War gives no clue, for as is well-known there was then, practically speaking, no attempt at deflation—the premium was got rid of by a gradual increase in production. Incidentally, inconvertible paper does not invariably lead to disaster—the result of its use depends entirely on the skill and restraint of the managers of the issue. After the Franco-Prussian War of 1870, France had to adopt inconvertible currency and was able to prevent it going to an appreciable discount.

The question arises as to whether, when the premium on gold disappears in the U.K., it will also disappear here. The answer to this question is also the answer to the question I have often been asked as to why our fortunes are bound up with those of England in this matter. As regards the first point, I think we shall lose the premium if U.K. currency goes to a par with gold. For let us suppose that, as is quite likely, gold remains at a premium in France, and that the gold in a sovereign will, instead of 25 francs, fetch 50 francs. But we need payment in Union currency, and we could only get more than £1 Union currency for the gold in a sovereign if the Paris-Johannesburg exchange were less than 50 francs per £1. But it cannot be less than that figure if we are on a gold basis; for if it were, Paris would buy Union pounds, convert them into gold, ship the gold, sell it for 50 francs and so *ad infinitum*. If, however, we were on the basis of inconvertible currency, the exchange would depend on the comparative level of prices here and in France, and, as such a condition of things would almost certainly lead to over-issue of notes, we would, in all probability, lose the premium very soon through higher prices forcing our exchange to a par with that of France. It follows that in such an event we would be bound to France for the same reason that we are to-day, so to say, bound to England. We are in both cases bound by the relation of buyer and seller.

Finally, I would like to say a word on the question of local inflation and the Johannesburg-London exchange, which is so frequently called abnormal. To you it is, of course, obvious that its only abnormality is that it is controlled. Our exchange is probably not a true one, because it is governed by a ring, and, if it is artificial, it is no guide as to whether there is inflation in this country. Its height is apparently largely determined by the exigencies of what the great Italian professor, Loria, calls a non-exportable gold standard. The banks have to import gold in respect of a proportion of the excess of their purchases of London money over their sales of the same commodity, and for this gold they have to pay the London price. It follows that if the excess of sales is £1,000,000, and the banks, to meet wastage, maintain and strengthen their reserves, decide to import £400,000 in gold in respect of this £1,000,000 the Johannesburg-London exchange should be 40% of the London premium on gold. And it would apear as if some such calculation as this determines the exchange rate of the banks.

There is, however, another influence, possibly equally important, at work, and that is that the banks, for reasons difficult to understand, have put themselves in the position of having an unusually large proportion of their South African liabilities represented by assets held in London. Obviously, these assets and the total of South African liabilities, and, therefore, the proportion of South African liabilities represented by London assets, will increase as long as their purchases of London money exceed their sales. Hence, their quotation for London money reflects not only their desire to cover further purchases in excess of sales by adequate gold imports but also their need to prevent further increases in their London assets. But the existence of a material gold leakage, which will, of course, continue even if purchases and sales of London money are balanced, involves the banks in the difficulty that the more successful they are in meeting the object last mentioned, the less money they obtain through their purchases of London money to meet the cost of gold imports. No wonder Parliament is having difficulty in solving the question!

Mr. Evans criticizes very severely the increase in the issue of the notes of our banks which has taken place in the last six years. But I do not think that this increase is necessarily a measure of the amount of inflation which has taken place in South Africa. In so far as such notes have replaced gold previously in circulation they do not represent inflation, and, further, the increase of production measured in quantities and not in values, which has undoubtedly taken place, also calls for an increase in the circulating medium. The latter cause would also cause deposits to increase. Then again, we cannot withdraw ourselves from the world so that, in any event, our prices should approximate to world gold prices, less cost of freight, etc. This would account for still further increases in notes and deposits. In the absence of a free exchange, it is difficult to know where we are; but I am inclined to think that inflation, apart from world inflation, is to date not very serious in this country, for our prices do not appear to vary greatly from the world's gold prices.

When the gold standard has been restored, the second stage of the problem, namely, a reduction of gold prices, in other words, an increase in the value of gold, is likely to solve itself automatically; chiefly perhaps through increase of production, which may be stimulated by being able to sell its wares for gold and by removal of the fear of the consequences of unforeseen and incalculable issues of inconvertible paper. But the process is unlikely to be very rapid.

Mr. D. C. Greig (*Visitor*): I do not believe the high prices now prevailing in South Africa are due to inflated currency, but are simply the result of the country's great prosperity, and the strength of private deposits operating in a field of scarcity. Taking into consideration the enhanced price of all commodities and also the general increase in wages, the note issues of the banks are not excessive.

I do not consider the quantity theory is of practical importance to anyone dealing in exchange, the only factor worth considering is the balance of trade and that the present position is really due to bad banking, the banks having overbought bills of exchange on London to which they can get no adequate set off.

I believe rates would still further advance and think most dealers in exchange are of the same opinion. Securities as a necessary consequence are falling and will do so until the real disparity is reached.

With reference to the prices of local commodities one could see the ordinary laws of supply and demand in operation. Beef, for instance, early in the year touched record prices, to-day it is practically back to pre-war prices. Mutton is equally scarce owing to the high price of wool, but is also falling with the decline in wool which forces sheep into the market for slaughter purposes. Securities also in South Africa have been forced up to unhealthy figures through shortage in supply, and the large sums offering for investment.

Now that the position of sterling is more assured large sums are leaving South Africa for investment in London, and gilt-edged South African securities are declining.

Mr. W. S. V. Price (*Member*): I should like to join issue with Mr. Evans to-night as to his statement about the strikes, especially in England; they were caused by the rise in prices of food. I am not very long from England, and I felt strongly about it while I was there.

SOME POSSIBLE CAUSES OF DISCREPANCIES BETWEEN MINE AND BUYERS' WEIGHTS OF GOLD BARS.

By H. R. S. Wilkes (*Member*).

(*Printed in Journal, November, 1919.*)

REPLY TO DISCUSSION.

Mr. H. R. S. Wilkes (*Member*): Mr. H. J. Brown, in his remarks on the notes under consideration, stated that the reasons put forward as possible causes of discrepancies had been well known to London smelters for many years, and that he did not know but that South Africa also was cognisant of them, which would have rendered it unnecessary that the paper should have been presented.

Mr. J. Hayward-Johnson mentioned that the subject was brought up many years ago in this Society, and the Editor of the Society's *Journal* has been good enough to give in a foot note numerous references to former discussions.

The number of these references would lead the casual reader to suppose that the writer had been "flogging a dead horse," but a careful re-perusal of them discloses the fact that the subject proper of these notes has never been discussed, nor have the apparent discrepancies ever been explained.

There is but one paragraph in the entire records of this Society's proceedings which touches upon the subject, and that is found in the interim report of the Sub-Committee appointed by this Society to go into the whole subject of bullion assay and disposal. It is to be found in Vol. II., page 793, par. 6, and reads thus:—

"In the course of the investigation another detail was discussed, upon which there was considerable unanimity of opinion, viz., in many cases an undue loss was shown in remelting the bars by the refiners. By an undue loss is meant that the fineness of the bar is not always proportionately increased, so that the loss in weight is not made up by the increased fineness obtained. Against this loss the companies on the Rand are entirely unprotected, and this is a matter which is of sufficient importance to receive more consideration as to the best means of preventing such loss."

The date of that recommendation was September, 1897, and whatever may have been done privately, nothing has been laid before this Society since then, until these few notes appeared, a matter of twenty-two and a-half years. The writer offers this as an excuse for presenting a paper which Mr. J. H. Brown might have considered unnecessary. Further, it is noteworthy that Mr. J. G. Johnson, of Messrs. Johnson, Mathey, & Co., and Dr. Kirke Rose, in their valuable contributions to the discussions did not see fit to enlighten South Africa on a point, specially mentioned by an influential committee of South African metallurgists, as a bone of contention between the mines and the buyers, and this at a time, when South Africa contended very strongly that she was not receiving fair treatment. An explanation at that time of the reasons for these apparent losses, well known as Mr. J. H. Brown has told us they were to the London smelters, would have done much to remove the misunderstanding. No such explanation was forthcoming.

Mr. Brown's confirmation of the writer's assumption that when pouring with a cover, slag is encased in the bar is very gratifying. The writer has also found slag floating on a bar remelted in a new pot, without flux, indeed it was that fact which led him to investigate the reason some fifteen years ago.

The late Mr. Bevington, as far back as April, 1897, noted a loss on 35 bars of mill gold, which while they lost nothing *en route* to London, on remelting lost 15·3 ozs. The matter was then looked upon as a mystery, if not a bit of sharp practice on the part of the smelters, though doubtless, it was due to encased slag, bars in those days being always poured under a slag cover.

The writer was unfortunate in using the phrase "as cool as possible." What he intended to imply was, that, after stirring and sampling, followed by skimming, which operations are always done at a good heat, it is advisable to pour, without further heating, the temperature having fallen owing to the opening of the furnace cover during these operations. A very hot pouring will frequently result in a badly pitted and deeply depressed bar, which is not likely to result if the pouring is comparatively cool.

Smelters are indebted to Mr. Kahan for his instructive remarks on smelting, and the writer expects that his advice will be largely taken advantage of.

With regard to skimming, and pouring without a cover of which method Mr. Kahan expressed a desire to be informed, it is only employed by the writer when dealing with gold in the region of 900 fine, and is carried out as Mr. Kahan surmises. Sufficient bone ash or other refractory absorbent (the writer uses burnt magnesite as the cheapest obtainable) is added, after the bar has been stirred and sampled, to thicken the slag to a stiff paste. If properly proportioned the whole of the mixture can be removed with the skimmer at one lift. The bar is then poured as cool as possible, and turns out of the mould so clean that a dip in the acid bath and a minute with the scrubber is all that is needed. When melting cyanide gold of a fineness of about 800 or less the writer uses the charcoal method as described by Mr. Kahan.

Mr. Kahan regrets that in the case of the 22 bars mentioned in the notes the fineness was not given. When it is stated that the average fineness was 901, it will be seen that the loss of 16·5 ozs. could not have been due to refining during remelting, the buyer's bullion assays being only 0·07 of a millieme higher than the mine result. Thus it is fair to assume that the apparent loss of gold was due to encased slag.

In conclusion, the writer wishes to express his regret that no criticisms have been forthcoming from local colleagues, since the points submitted would appear to have been of some interest.

SOME SUGGESTIONS ON IRRIGATION

By A. Baguley, B.Sc., F.I.C. (*Member*).

(*Printed in Journal, March, 1920.*)

DISCUSSION.

Mr. W. Ingham (*Contributed*): I regret that it is impossible, owing to pressure of business to comply with the request to contribute to the discussion on Mr. Baguley's paper on Irrigation, but I may say that I agree with the writer of the paper that it is absolutely necessary to have the co-operation of the Chemist, the Agriculturist and the Engineer if an irrigation scheme is to be carried out in a scientific manner. There is one other point which I desire to refer to, and that is the question of underground irrigation. This system was adopted in California on a large scale, but was unsatisfactory from two points of view:

(a) The prime cost was very high

(b) The roots of trees, etc., entered the pipes and interfered with the flow of water and indirectly caused a considerable loss of water at such points.

Mr. F. E. Kanthack (*Contributed*): The matter raised by Mr. Baguley is one in which I take very great interest, and, as Dr. Caldecott has stated during the discussion, I have strongly urged more scientific co-operation between the irrigation engineer and the chemist. For some years past I have been impressing upon the Agricultural Department the necessity for expanding their chemical branch, more especially in the direction of the chemistry of soils, and I am glad to say that progress is now being made in this direction. The relationship between the chemist and the irrigation engineer has been for a long time past fully appreciated in the United States of America where nearly all the troubles which we have to contend with in the arid and semi-arid portions of South Africa are also met with. What we particularly require to study in this country are the alkali soils (and Karroo soils are all alkaline), and their proper treatment under irrigation. Apart from this a great deal of research work is necessary in order to discover the most efficient method of irrigating "mechanically" difficult soils. Every practical irrigation engineer knows that sandy soils require much less water to produce a crop than heavy, clayey soils, and the reasons for this are fairly well known; but the whole question of the requirements of water by different plants and the requirements of water by different soils, and the most efficient application of irrigation water both in regard to quantity and method of application are all things which have been treated in far too haphazard a manner. Irrigation water in South Africa is very deficient in quantity. We have not a tenth of the water necessary to irrigate the best of our land, and at the same time our irrigation methods are on the whole exceedingly wasteful. It behoves us, therefore, to do everything possible to increase the efficiency of our irrigation.

It may be of interest to the Society to know it has recently been decided that a number of our junior engineers are to be sent for a year to the University of California to study the chemistry of soils, the nutrition of plants and other subjects relating to the science of irrigation. It is hoped for some years to come to send two young engineers to America each year. In course of time it is hoped that some of our Universities and Agricultural Schools may be sufficiently well equipped to relieve us of the necessity of sending these young men abroad, but as things are at present it is quite impossible for them to obtain a training of this kind in any other country than the United States of America.

Mr. Arthur Stead (*Contributed*): It is indeed gratifying to find that your Society possesses that breadth of view which has led to Mr. Baguley's paper on some of the agricultural aspects of irrigation.

While it is to irrigation alone that we must look for any appreciable increase in the output of foodstuffs over the very large area of arid South Africa, irrigation may also be counted on to increase the yields of crops in what may be called our sub-arid regions. The subject is truly, as your President has said, one of greatest importance to the future of this budding nation.

There are two principal lines on which irrigation development can proceed, i.e.,

(1) In the direction of increased conservation of surface waters.

(2) In the attainment of an increased "duty" of water. Mr. Baguley's suggestions fall under the latter head.

Dr. Caldecott would seem to infer in his remarks that Mr. Baguley has somewhat missed the mark with regard to the function of the soil water as a carrier of oxygen. This aspect of irrigation appears to me to be of such supreme importance that, at the risk of being wearisome, I will enter into this question in some detail.

Plant growth is a series of chemical changes involving two types of synthetic processes (*i.e.*, the synthesis of carbohydrate from the carbon dioxide of the atmosphere and water and the synthesis of protein) and one katabolic process involving the absorption of oxygen, the destruction of carbohydrate and the production of carbon dioxide, which process is exactly analogous to respiration in animals.

Every living plant cell requires free oxygen for respiration purposes; the chief source of it being the oxygen dissolved in the soil water. Further, at germination and maturation the respiratory process dominates the synthetic processes, and the plant loses weight. Any interference with the air supply in the soil at these times is attended with diminished yields.

Soil is not an essential for plant growth, for plants can be grown in water culture from seed to maturity, provided the culture solutions are aerated from time to time. Should the culture medium be not well oxygenated growth will certainly be poor; but I have difficulty in associating the cause with anything other than a deficiency of oxygen to meet the needs of respiration, particularly of the roots. There would seem to be no need to postulate the production of poisonous reduction products.

Plants can also be successfully grown to maturity in sand culture,—conditions more nearly approaching the soil than the former. Under this system of culture, water and nutrients are supplied as required. As the water supply is increased so does the yield increase, up to a point, after which there is a decline for further increments of water. Beyond the point of maximum yield the sand becomes so charged with water that there is not sufficient air in the vacant spaces between the sand particles to aerate adequately the water supply. By careful experiment it has been shown that the optimum moisture content varies between about 40% and 60% of the quantity required to fill all the vacant space between the particles. If the optimum moisture content is exceeded water, by excluding air, becomes a limiting factor in growth. Again it is difficult to accept the formation of toxic reduction products as the cause of diminished growth.

Similar water phenomena are met with in ordinary soil, and should the water content of the soil approach that required to cause complete saturation, that is, waterlogging, I agree with Mr. Baguley that through anærobic bacterial fermentations toxic reduction products are produced.

Excepting carbon dioxide, the plant grown under natural conditions depends on the soil for all of its food materials. Of these latter nitrates form an important group. A variable insufficient amount is brought to the soil by the rainfall; the rest is produced by the oxidation of organic nitrogenous matter in the soil through the agency of certain ærobic bacteria generally referred to as the nitrifying organisms. It is obvious that these organisms, whose habitat is the colloidal gel which covers the soil particles, cannot function normally if the soil water is lacking in free oxygen.

Moreover, under conditions of poor aeration of the soil a group of organisms, known as the denitrifying group, derives its oxygen requirements from nitrates, the nitrate being, of course, destroyed in the process.

Then there is a group of organisms in the soil known as the nitrogen fixing group: it is responsible to a large extent in maintaining the nitrogen content of the soil. This group needs an abundant supply of oxygen in the soil water.

Such are the reasons that forbid one from accepting Mr. Baguley's dictum that the soil water must carry oxygen "for the health of the soil." It would have been more satisfactory to say: "for the respiration of the plant, for the life processes of ærobic bacteria and for the inhibition of anærobic organisms."

Mr. Baguley is correct in stating that rain is usually much better than any other kind of water; but I think he will admit that rain may be quite as cold, even colder, than stored water. The superiority of rain would seem to be due to the manner of its application and also to the fact that it directly increases the oxygen content of the film water, oxygenation of the film water from the soil air being a much slower process.

Mr. Baguley's remarks on drainage are to the point, and most people will agree with what he has said on this subject. It seems a pity that the designation "drainage" has been fixed on the installation of pipes, etc., below ground, for, although excess water is carried away through the pipes, this function is by no means the only one the drains perform; their work in aerating the soil is just as important. I would like to emphasise that, apart from considerations of "brak," drainage increases the duty of water by producing a well-developed granular structure in the soil to great depths, thereby causing a more perfect distribution of the water applied to the surface of the soil, the wide proliferation and deep penetration of roots.

In referring to Mr. Baguley's remarks on drainage Dr. Caldecott suggests that the farmer should choose only those lands which are naturally well drained. Apart from that not often being possible it would debar the farmer from making use of his richest lands.

Dr. Caldecott also made some reference to the fertilising value of silt carried by rivers, instancing the classic Nile. I would like to say here that I have investigated cases of declining fertility under irrigation in which I have come to the conclusion that the silt has been the cause of infertility. As to whether a silt will be beneficial to the land or not depends on whether it improves or spoils the physical make-up of the soil. Many of our rivers carry excessively fine silt, a fact which appears to be due to the presence of sodium carbonate in the soil over which the water has flowed, sodium carbonate being a very powerful deflocculator. When such a water is impounded it deposits the coarser material (if it carries any) the finest remaining in suspension, sometimes for months.

If the average alluvial soil is irrigated by such a water it must be expected that its fertility will decline, for the reason that it will become more and more colloidal in character. On the other hand one would expect such a water to prove beneficial on a sandy soil, at least for a time.

Regarding the crusting of soils or the caking of its surface, I note that Mr. Baguley attributes this to the cementing action of salts which the water dissolves from the soil. I would like to ask Mr. Baguley whether he has any figures in support of his view. The alkaline carbonates could certainly cause such a caking, but I would expect small amounts of the other salts normally present in soils to have an opposite effect. That this is so would seem to be borne out by the highly flocculated state of the surface soil of areas where there has been a rise of alkali consisting of sulphates and or chlorides.

The soils which cake worst, excluding those where alkaline carbonate are the cause, would seem to be those which contain a high percentage of fine sand (0·2 to 0·04 mm. in diameter).

To remedy this condition, Mr. Baguley suggests the sub-irrigation method of applying water. There is much to be said for this method, but possibly more against it. It has been found successful under very special conditions only, and is probably very wasteful of water. There will be a saving of water evaporated at the surface, but that is usually more than counterbalanced by the increased losses from percolation. A type of sub-irrigation, *i.e.*, the furrow method of irrigation has, however, been adopted with considerable success in America. The method seems to have not been practised here. It has the objection of all sub-irrigation methods that it is likely, if alkali is present, to lead to a concentration of it in the surface soil, necessitating flooding from time to time. Generally speaking, the method is an excellent one for use with the finer-grained types of soil. The unwetted surface between the furrows affords an easy escape for the soil air and thereby the entry of water into the soil is facilitated.

THE IDENTIFICATION OF QUARTZ PARTICLES IN KONIMETER SAMPLES.

By Dr. A. W. Rogers, F.R.S. (*Member*).

(*Printed in Journal, April, 1920.*)

DISCUSSION.

Mr. A. J. R. Atkin (*Visitor*): This method of Dr. Rogers is simple and easily applied, and is of great use in further strengthening the searching power of the konimeter. The method I use in applying it is as follows, using ⅛ objective and Zeiss eyepiece No. 5. The refractive index of the solution is first adjusted, by mixing the two liquids and trying its index on a slide of pure quartz dust, and one of the dust from the banket. It should be so adjused that about the same amount of raising the tube will show the minerals higher than quartz as white spots as of lowering will show the quartz. Then a slight motion of the fine adjustment screw right and left will show both minerals without further trouble.

The slide (perhaps containing 3 spots of dust) is placed on the stage of the microscope, and the spot of dust selected with a low power. The slide is now clamped in position, the high power turned in, and any suitable part of the spot chosen (*i.e.*, where there is a convenient number of dust particles).

A piece of cover glass is now taken and laid on the slide close to the dust spot, which can easily be done with a forceps, and then another piece, about 1 cm. × ½ c.m. placed bearing upon this piece.

The microscope is now focussed on the spot though the cover glass, which does not touch the spot and leaves a space for the liquid.

A drop of liquid on the point of a glass rod, is taken and applied to the edge of the inclined cover glass. Capilarity spreads it under the cover glass at once, and on refocussing the dust particles are seen as before, but in a yellow medium, and the optical work can be commenced at once.

This is the easiest way of using the method that I have been able to devise, and one hardly ever spoils a spot of dust, as is easily done if one tries putting the liquid on the spot, and then the cover on the liquid.

The ⅛ obj. and No. 5 eyepiece show ½ a particle quite easily, and a little movement of the substage condenser shows a point where definition is best.

The only samples from underground available at the moment gave the following results:—

Mine.	Total Amount.	% Quartz Particles.
Brakpan	1,000	65
Brakpan	700	46
Sub Nigel	500	70
Village Deep ...	800	82
Crown Mines ...	300	60

Average of 5 spots of dust.

which gives an average of about 65% of quartz particles in these dust spots.

Apart from manipulation of the cover glasses and keeping the lenses untouched by liquid there is no difficulty in applying the method. It must be noted, however, that it is better to mix fresh liquid as required, for after some time the liquid decomposes, with separation of crystals, and lowering in refractive index to below that of quartz.

If this figure of 65% of quartz in the dust in mine air is representative, it shows that the quartz is even more deadly than might have been thought, for miners' phthisis is not yet stamped out. Nothing but ceaseless vigilance, coupled with constant sampling with the konimeter, will enable us to better the present conditions. The constant sampling by the Chamber of Mines dust samplers, show that they rarely find counts of over 1,000 particles per c.c., and the difference between their bi-monthly dust surveys of the Witwatersrand is generally a matter of the decimal place in mgs. of dust per cubic metre of air.

This shows that we have reached the limit of the capacity of the gravimetric method of dust determination to indicate danger, for the Miners' Phthisis' Prevention Committee (Final Report, 10th January, 1919, page 7), speaking of the accuracy of this method, says, *inter alia*, "What the precise measuring of a sample returned as 1 mg. or less per cubic metre is, is doubtful." An analysis of the figures given by Dr. Watkins Pitchford and Dr. Moir (on the nature of the doubly refracting particles seen in microscopic sections of silicotic lungs . . .) is striking and decisive.

They show that 96% of the quartz particles in the silicotic lung are under 3 microns in diameter, and the average diameter is 1.1 microns. As it would require about 2,000 million particles of this size per cubic metre of air to weigh 1 mg., it follows that a konimeter count of 2,000 particles per c.c. would be required to give a figure of "doubtful meaning" (see Miners' Phthisis' Prevention Report quoted above). Yet counts of 2,000 particles per c.c. are seldom obtained. Under these conditions nothing but investigation with the konimeter will give any safe index of dangerous conditions or give us a guide to safety, and Dr. Rogers' method further illumines the dangerous road.

Dr. J. Moir (*Past President*) (*contributed*): I have been much interested to learn from Dr. Rogers' paper that the "white-line method" of distinguishing minerals can be applied to particles which are too small to have a definite shape even under high magnification. I should mention, however, on the question of priority, that about 10 or 12 years ago when I was attempting for the first time to photograph mine dust under polarised light, Mr. Max Weber, then Curator of the local Geological Museum, showed me the white-line method as applied to mine dust. After this lapse of time, I do not remember what the refractory liquid was, but think it was oil of cassia diluted with xylene or turpentine. At that time, of course, everyone thought that dust as small as 5 or 10 microns was about the limit that need be examined, and it is a most valuable discovery to prove that the white-line method does not fail even if particles less than the micron have to be differentiated.

It would be an improvement in Dr. Rogers' method to employ a liquid which is not a mixture but a chemical individual. There are several organic liquids suitable in respect of refractive index and high boiling-point, such as orthotoluidine or dimethylaniline. These would not alter in refractive index by keeping or evaporation, and do not darken much on keeping.

NOTES ON ROUTINE ASSAYING AT THE GLOBE AND PHŒNIX GOLD MINE, SOUTHERN RHODESIA.

By H. R. Edmands.

(*Printed in Journal, April, 1920.*)

DISCUSSION.

Mr. G. A. Watermeyer (*Vice-President*): The author has given us a most informative paper on the procedure on his mine, and he deserves great credit therefor. His extract from the law of averages, however, is open to a good deal of criticism. The subject is very intricate and one has to lay down the premises very clearly before applying a formula.

The problem which the author endeavours to solve is the determination of the greatest error to be feared in the result of an assay. He assumes that it is dependent upon the fineness of grinding. In my opinion it will depend upon the quantity crushed and the proportion thereof taken for assay. In the process of assaying the temperature being sufficiently high and the fluxes used being such as to render all the gangue fluid the gold will be available for solution by the lead and the weight would be independent of the number of particles since they would sink to the bottom and be absorbed. The author has dogmatically applied Poisson's formula for the greatest error to be feared. It would be very interesting if he took two quantities of the same ore, say, 12 lbs. in weight, reduced one to pass through a $\frac{1}{60}$ inch sieve and made 100 assays thereof. Reduced the other to pass through a $\frac{1}{200}$ inch sieve, and made 100 assays of this as well. It would then be possible to arrive at an empiric measure of the deviations to be expected from the combined factors of laboratory sampling and assaying. Also whether the effect of fine crushing is such as to reduce this deviation as claimed by the formula.

The expected value of a variable quantity which may assume any one of a large series of values such as $\alpha_1, \alpha_2 \, --- \, \alpha_n$ is the sum of the products of each individual value of the variable by the corresponding probability of existence of such value.

If p be the probability of an event happening at a single trial the expected value in s trials will be s p.

The expected deviation from the expected value will be $\sqrt{s.p.q.}$ where $q = 1 - p$. The formula quoted by the author may be obtained by substituting for $s = x + y$, $p = \frac{x}{x+y}$ and taking the limit of deviation as $\sqrt{8}$ times the expected deviation from the expected value. Fisher in his Mathematical Theory of Probabilities expresses the problem as follows:—If p is the postulated *a priori* probability and $\frac{\alpha}{s}$ the empirical probability (*a-posteriori*) or relative frequency of an event E, what is the probability that the difference $\frac{\alpha}{s} - p$ does not exceed a previously assigned quantity?

He states Tchebycheff's rule that the probability PT of a deviation of a variable from its probable value, not larger than λ times its mean error is greater than $1 - \frac{1}{\lambda^2}$

For	$\lambda = 3$	$P_T > 1 - \frac{1}{9} = 0{\cdot}888$
	$\lambda = 4$	$P_T > 1 - \frac{1}{16} = 0{\cdot}937$
	$\lambda = 5$	$P_T > 1 - \frac{1}{25} = 0{\cdot}96$

In the instance quoted—

$\lambda = \sqrt{8}$ $\qquad P_T = 1 - \frac{1}{8} = 0{\cdot}875$

I should much prefer to hav[illegible] confirmation as outlined above [illegible] accept the statement that the devi[illegible] be feared from the true value may be or three times the expected value dependin[illegible] upon the fineness of crushing.

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MERCURIAL POISONING.

By Dr. A. J. Orenstein (*Member*).

(*Printed in Journal, April, 1920.*)

J. M. Neill (*Member*)—(*Contributed*): Arising out of my question on the above and the reply thereto[1] I am of opinion that liability to poisoning by contact with metallic mercury, as used in amalgamation processes, is an almost impossible contingency. Poisoning by inhalation of mercury fumes arising from retorting is an established fact.

From the following statement, it will become evident, that a contaminant, which is readily absorbed by the skin, must be present, otherwise clean mercury will not enter the tissues.

The question of the very fine subdivision of metallic mercury does not affect the case, if that fine subdivision is due to a substance not in itself readily absorbed by the skin. Nor do cuts and abrasions in hands and arms have any effect. It is admitted that mercury rubbed up with grease, which the skin can absorb, will create poisoning—mercury rubbed up with clay, which is not easily absorbed, does not enter the skin. The statement beforementioned is simply, that during ten years, I squeezed by hand through amalgam cloth, frequently loaded with clay, upwards of 2,000,000 ozs. of mercury containing amalgam, without suffering any ill effect. Generally speaking, it was exceptional to have hands quite free from cuts, abrasions or cracked skin. When recovering amalgam, from finely ground black sand particularly, it was impossible to keep the hands clean, the result being that the cuts and cracks were filled with this material containing appreciable quantities of finely divided metallic mercury. The arms were daily plunged into mercury half way up to the elbows, in the course of those operations, and the theoretically favourable conditions to bring about mercury poisoning were set up, with no practical ill effect. This state of affairs was common to many men then, and is common now.

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[1] This *Journal*, Vol. XX., April, 1920, pp. 176.

Therefore, although I agree with the general conclusion that cleanliness by mercury workers before eating, and, may I add, before filling the pipe and smoking, will minimise a not very great danger of poisoning, I feel that the worker need have no fears whatever of poisoning by contact with clean metallic mercury.

There being no further discussion, the meeting then terminated.

The Annual Dinner of the Chemical, Metallurgical and Mining Society of South Africa was held at the Carlton Hotel, Johannesburg, on Saturday, May 8th. Mr. Jas. Gray, F.I.C., President, in the Chair, and there also were present—

Mr. S. Scott (Deputy Mayor of Johannesburg), Mr. H. R. Adam, Mr. A. Aiken, Mr. R. Anderson, Mr. H. O. Buckle (Pres. Transvaal Chamber of Mines), Dr. W. A. Caldecott, Mr. P. Cazalet, Mr. J. Chilton (Vice-President), Mr. A. B. Coetsee, Mr. D. Christopherson, C.B.E., Mr. W. H. Cross, Col. W. Dalrymple, Capt. B. N. Donald, Mr. P. Duncan, C.M.G., Mr. W. Elsdon-Dew (Pres. S.A. Institution of Engineers), Mr. W. G. Fern, Mr. A. French, Mr. H. Goodwin, Mr. K. L. Graham, Mr. H. L. Harland, Mr. T. M. Harris, Mr. W. T. Heslop, Prof. J. H. Hofmeyr (Principal S.A. School of Mines and Technology), Mr. Hubbard, Mr. H. J. Ibbotson, Mr. R. Islip (Pres. Chamber of Commerce), Mr. H. A. G. Jeffreys, O.B.E. (Secretary of the Society), Mr. E. H. Johnson (Past President), Mr. J. Hayward Johnson, Mr. A. King, Mr. A. N. Locke, Mr. P. Macdonald, Dr. J. McCrae (Pres. S.A. Assn. Analytical Chemists), Dr. R. P. Mackenzie (Pres. Wit. Branch British Medical Assn.), Mr. H. Rose Martin, Mr. F. A. Maxwell, Mr. H. S. Meyer (Past President), Dr. J. Moir (Past President), Mr. C. L. Moon, Mr. P. T. Morrisby, Mr. J. Munro, Mr. R. Newhall, Mr. H. Newhouse, Mr. S. Newton, Mr. T. A. O'Kieffe, Dr. A. J. Orenstein, Lt.-Col. E. Pam, O.B.E., Mr. A. E. du Pasquier (Pres. A.S. Institution of Electrical Engineers), Mr. S. H. Pearce (Past President), Mr. S. R. Potter, Mr. F. C. Rigby, Mr. F. Rowland, O.B.E., Mr. J. J. R. Smythe, Advocate C. J. Stallard, K.C., D.S.O., Mr. Stone, Mr. W. E. Thorpe, Mr. J. R. Thurlow (Hon. Treasurer), Mr. C. Toombs, Mr. M. E. Walsh, Mr. F. Waternweiler, Mr. G. A. Watermeyer (Vice-President), Mr. F. W. Watson, Mr. J. Watson, Mr. E. F. V. Wells, Mr. H. A. White, Mr. J. Whitehouse (Pres. Mine Managers' Assn.), Prof. J. A. Wilkinson (Past President), Mr. J. S. Willcox, Mr. L. B. Wilmot, Mr. H. Wilson, Mr. W. Wilson

After the dinner the Chairman read letters of apology from the Hon. F. S. Malan (Minister of Mines), the Mayor of Johannesburg, Sir Robert Kotze (Government Mining Engineer), Sir Harry Lauder, Mr. J. R. Leisk, Mr. T. R. Leslie (President of the Geological Society), Sir Spencer Lister, Mr. F. R. Lynch, Sir Harry Ross Skinner, and Mr. Ernest Oppenheimer.

The toast of "The Society and Industries," was proposed by Mr. H. O. Buckle in humorous terms, in which he indulged in some gentle satire upon the meaning of the design of the Society's monogram that was provocative of a good deal of merriment. It would be absurd, he said, if he were to point out to them all the valuable services that the Society had rendered to this country and Johannesburg, from the days when it contributed so much to the development and perfecting of the cyanide process, to the more recent times when its discussions contributed so much to getting over the difficulties entailed upon them by the recent war. He supposed that he was right in talking about the "recent war," for he had not been able to gather from the newspapers as to whom they were now at peace with. (Laughter.) Perhaps it would tend more to illustrate the catholic scope of the Society if he were to take a dip into the future and call their attention to the fact that very shortly the Society was going to listen to a paper by Mr. Samuel Evans on the subject of the problem of the exchanges. He did not know whether in dealing with that subject Mr. Evans would be speaking as a chemist or a metallurgist or a miner. (Laughter.) And then he (Mr. Buckle) was asked to propose also "Industries." Well, he was not quite clear what that precisely meant. He knew about one industry in this town that they commonly spoke of as "the" industry, but what the other industries were that he was requested to talk upon he was not quite clear. But in order that he might learn something about it he had been carefully studying the coat-of-arms of the Society, and he was glad to see that that properly recognised the supreme importance of the mining industry. Having entertained the company upon what he described as his "frivolities" in his comments upon the coat-of-arms, Mr. Buckle said it was universally admitted that every kind of modern industry depended on science for its support and increase and progress, and no kind of industry could do without the assistance of science, as typified by the chemist, the metallurgist, and the miner. (*Applause.*) He coupled with the toast the name of the President.

The Chairman on rising to respond was greeted with applause. He said:

He had to thank them for the manner in which they had received this toast, which had been so appreciatively proposed by Mr. Buckle. It was peculiarly fitting that the President of the Chamber of Mines should have proposed it in view of the generous financial support which the Chamber had so recently given to the Associated Scientific and Technical Societies of South Africa in connection with the scheme for joint-housing, and so enabled them to obtain a home. He was sure that the value of the work of the various Societies to the community, comprehensive as it had been in the past, would be greatly enhanced in the future, under the new auspices.

Many of the usual activities of his Society ceased temporarily during the war, but were now gradually being resumed. One of the most notable was the Annual Dinner, which was being held that night after a lapse of six years. The events of that period were still uppermost in their minds, and they could not forget, even on an occasion like that, those of their members and associates who had given their lives on the field of battle.

The Annual Dinner was a function which enabled them to descend from the pedestal on which they had been placed by their lay brethren, and afforded them an opportunity of expressing their high opinion of the importance of the Society's work to the welfare of the body politic. He might say that they expected this flattery, and would be disappointed if it were omitted. But, joking apart, they desired that their guests would get to know and understand better their aims and objects, and the acquaintanceship thus formed would develop into a firm and enduring friendship: for there could be no doubt that they could mutually benefit by such a friendship which enabled them to appreciate and be in sympathy with one another's ideals.

His Society was, and he said it without fear of contradiction from any friends present, the premier Scientific Society of South Africa, for it was started before the others were thought of. (All Presidents were entitled to make this claim!) Founded some 26 years ago, it had steadily gone on disseminating knowledge in connection with the subjects embraced within its threefold title. As might be expected, its *Journal of Proceedings* traced the history of the development of the great gold industry represented by the proposer of the toast, an industry which had yielded, and continued to yield, both directly and indirectly, the major proportion of the revenue of the Union. The *Proceedings* also showed the gradual development of many of the industries which were perceptibly helping to build up South Africa into a great and self-contained nation. The future which lay before the Society was encouraging, and the work to be done no less important than that which had been done.

From small beginnings, the industries, other than the mineral industries within the Union, had gradually expanded until now the gross value of the factory production was equal to, if not greater than, the value of the mineral production. The future would certainly see large industrial developments especially if attention was directed towards the effective utilisation of the vast natural resources of the country. Assistance in this respect must be sought, to a very great extent, from the Government. It was, however, a very difficult and apparently impossible matter to get the controllers of their destinies (who, by the way, were, as a result of their recent efforts at the poll, a very heterogenous collection), to see eye to eye with them in this connection in view of the obsession which apparently prevailed in all political circles of the absolute necessity of doing nothing which might endanger one's seat at the next election (even to the extent of failing to support one's own amendment in the House). Yet, he believed that the very soundness of the arguments which supported this need for assistance in the end must prevail. One of their Captains of Industry, he referred to Sir Lionel Phillips, a very good friend of the Society, said recently in addressing an assemblage of agriculturists, "South Africa wants more work and less politics," and they all, be they politicians or otherwise (and to-night they were mostly otherwise) realised the truth of that statement.

The question arose, In what respect could the Government render assistance to those desirous of promoting industries? There were several answers to that question, but he considered that the greatest benefit would result by the establishment of a Chemical Research Bureau. Chemistry, it was unnecessary to point out in these enlightened days, was inextricably bound up in all industrial and other enterprises. (That statement could not be denied, however much it might be deplored by the votaries of other sciences.) The problem of the successful utilisation of the natural resources of the Union was one which must inevitably fall within the purview of the research chemist. By Chemistry, he did not mean that clap-trap article which they occasionally found in the columns of their local press. One effusion in particular which he remembered suggested the use of old tailing dumps as a fertilizer. The suggestion of a research bureau was by no means original as it has been urged by Scientific Societies, the Press and elsewhere in season or out of season for many years, but, so far, without success. Research was necessary in order that the discoveries of pure Science to-day might become applied Science tomorrow. It was one of the most profitable investments which any Government could make, not only for posterity but for present times as had been proved by other, should he say, more enlightened Administrations.

Lord Leverhulme, a recent distinguished visitor, emphasised South Africa's industrial possibilities to an interviewer, he believed his large enterprises here would soon be considerably extended, thereby showing his faith in this country.

Research, however, only pointed the way, and something further was required. Capital and Labour were two additional essentials and were inter-dependent and no amount of glib oratory could divide them. Nor could the nationalisation, nor municipalisation, nor socialisation of industries separate them, and any attempt in that direction would only result in complete paralysation. It was not the duty of the State to gamble with the people's money, and, therefore, industries could only be developed and expanded by the capitalist, and if his reward was not commensurate with the risk, advance could not be expected.

To-day the profits resulting from industrial enterprises might be on a smaller scale than had been obtained in the past. To expect employers of labour to keep works running altogether for the sake of the workers was silly. Higher wages, combined with shorter hours and decreased production would inevitably result in chaos. Labour was apparently getting beyond its leaders' control. The spectacle of labour leaders, appealing to their followers to adhere to the procedure, which after much consideration had been mutually agreed upon by employer and labour's representatives for the settlement of matters in dispute, would be amusing if it were not pitiful. On the flimsiest of pretexts, as they knew, a strike at any moment might be called, when the difference could be settled by a few minutes' reasonable discussion. Labour to-day appeared to be like a spoiled child; in that the more it got the more it wanted, and it never ceased to ask for more and still more. In fact, there was no limit to its demands. It battened on agitation and seemed to grow in arrogance as it went on distending on its spoils, apparently in its greed forgetting that there was a bursting point.

He felt that there must be more stability with regard to labonr, before permanent and new industries could be established. While he, for one, did not grudge labour a "fair deal" and better conditions than had been its lot in the past, he thought that there should be some consideration shown towards the other fellow, and by the evidences of recent days, this consideration was either entirely lacking or unthought of. The necessity of organisation if one was to obtain an improvement or amelioration in the conditions of employment had been brought home very forcibly to those who were not ranked among the employers during the past few years.

The manual worker had obtained great success by organisation. His example had been followed by men engaged in those occupations which may be classed as on the border line of professions.

As a consequence, the professional man had realised the necessity for adopting the same procedure in an endeavour to improve his status and financial condition. Unfortunately the professional man's feelings would not in all cases allow him to use the weapon of the artisan. When his appeal to the employer's reason and sense of justice had failed, he did not withhold his labour. Many employers who apparently were only too willing to grant the artisan his many demands, frequently unreasonable, would unhesitatingly refuse to grant even a portion of the reasonable requests of professional men. They knew it was highly improbable that steps would be taken to compel the employer to meet them. Such employers only recognised the sledge hammer method. He would suggest that employers give serious consideration to the position of those technical employees whose brain was their asset. To fit themselves for their profession had cost money, time and labour. Was it fair that they should receive less pay than unskilled labourers or skilled ones who earned while they were learning?

He was sure that those who would control the destinies of the Society in the future would maintain the high traditions of the past.

Mr. Patrick Duncan proposed the toast of "South Africa." He thought it was fitting, he said, that the toast should be proposed at a gathering of this kind, and that something should be said from the point of view of South Africa as to what had been done for South Africa by the industry with which the Society was connected. If they were not aware of the fact, he might tell them that it had not always been recognised. He sometimes thought that the mining industry in South Africa, like many individuals in the world, would never receive its due meed of approbation until it was dead. (Laughter.) Then perhaps, if not before, some recognition would be expressed of what had been done for South Africa by the mining industry. It had for many years, under many administrations and different flags, performed the humble, unostentatious, but useful occupation of paying. (Laughter.) Whatever had been proposed or done or achieved in South Africa, the mining industry had paid. Its was a most useful function. He had heard it said in that august place, the House of Assembly, which he used to frequent—(laughter)—that Providence had expressly put it there for the purpose of paying, but not of speaking. He had heard it said, by a prominent South African, whose name he should not divulge, when the question was being discussed of a University in Johannesburg, that it was unheard of that Johannesburg should want a University. He said that Johannesburg was put there by the Almighty to take gold out of the ground to provide Universities elsewhere. (Laughter.) Well, whatever people might think or say, he (Mr. Duncan) was quite sure that if not before, at any rate after the death of the industry, whenever that should come, the people would recognise what had been done by that industry in building up South Africa, not only financially, but in bringing to this country men who had devoted their energies and abilities and scientific acquirements not merely to the tasks put before them by the mining industry, but to making the path smooth for other industries, perhaps of a more permanent nature, which would flourish after the last ounce of gold had been extracted from the soil of South Africa. He did not know if it were true as suggested by Mr. Buckle, that they were all going to take to agriculture when the mining industry no longer afforded scope for their energies, but he sincerely trusted that it would be so, for there was much yet to be done in the exploitation of their agricultural resources. He had been trying to be a farmer for some years past, and he was prepared to sell his holdings—(laughter)—at a reasonable figure, to some scientific expert who would succeed in producing more mealies to the square inch than he had been able to. (Laughter.) Well, it was no use shutting their eyes to the fact that South Africa from an economic point of view was passing through a difficult phase at the present time. They were in a way changing gear; they were getting on to another basis of production perhaps. Many of the mines that had stood them in great stead in the past were going out of existence or threatening to do so, and it seemed to him to be in the interests of the whole community that that change of gear should be effected with as few bumps as possible. It was an operation that could not be got through quite painlessly. It was likely to involve a good deal of trouble, and unemployment and loss of property and dislocation, but he thought that they had got to look on it not from the view of individual companies. They had got to consider that the closing down of the mines was not a matter that merely concerned the shareholders in those mines, or merely the employees in them. It was a matter of national importance, and should be taken in hand as such. It was to the interests of everyone whether they were actually here or were only connected with South Africa by financial interests, to see that this transition stage which must come some day, was brought about with the least possible amount of individual suffering and dislocation, and the least possible amount of unemployment; and all of them, politicians like himself, mine owners, and mine workers, had got to lay their heads together to see that this problem was tackled from the point of view of the community, and not from the view of any section of the community at all. (Hear, hear.) And if that was done and the problem was tackled with the fullest regard to the interests of all those concerned, and especially of the community as a whole, he thought that they had enough public spirit and ability to see that the difficult points—the bumping so to speak—were got over with the least possible amount of public trouble and discontent. (Hear, hear.) South Africa was a wonderful place, and its affairs had always been interesting. There was always something new—and by inference, something unpleasant, coming out of Africa. Whatever qualities or disqualities they had, and however they might be described, they were never dull. And at the present time they were not alone in having something to excite their interest and demand their attention. All over the world there was a great deal of unrest and trouble—the overthrowing of old ideas, and a painful attempt to put something new in their place. The effort was to get a better state of things, and therefore he thought they should not be too much afraid when they found that things were a little more unsettled than they thought they were going to be, and when they found that the old bases of authority were being overthrown or disregarded. That, he thought, was a necessary consequence of the time that they lived in. People were not now prepared to accept the authority that they were prepared to accept some time ago. People who were prepared to work under the direction of others and to ask no questions and take their wage, adequate or inadequate, were no longer prepared to do so, and they wanted to have some say in the conditions of the industry in which they worked, and they were going to have it. And if of course in that process some of their old ideas were upset and they were subjected to some annoyance—having to walk home when they thought they were going to find a comfortable Municipal motor car to carry them—they must not regard that as if the end of the world had come. (Laughter.) All these things took time and trouble. People had got to learn the limits of their power, and had to learn that although the old authorities had been overthrown, no business, no industry, no community, no State could exist without some form of subordination and some form of control and discipline. (Hear, hear.) Even Mr. Lenin had learned that lesson, and although it had been an expensive one to his countrymen he had learned it, and whatever this new world they were all moving to was going to be, and whatever shape it was going to take, they must be prepared to put up with some of the teething-pains of the infant state through which they were now passing. They must be prepared to give and take and look at questions from the point of view of the community, and that he hoped they would do. It seemed to him that they in South Africa had had a useful experience in that respect. They had seen in Johannesburg and in the mining industry a very great change within the last six or seven years. They had seen men who were employed in that industry taking a share of the responsibility which they never had before, and on the whole taking it well. He did not say that there were not exceptions to that rule, as there were exceptions to every rule. All of them who found new power put into their hands were inclined to use it rashly and not too wisely, but the only way by which people could learn was by responsibility. They would never teach people by preaching at them or fighting them, but by giving them a share of the responsibility as members of the community to which all of them belonged. (Hear, hear.) They had been told that one of the curses of South Africa was too much politics. He himself was an old politician, who at that moment was suffering from a lock-out—(laughter)—and therefore it might be thought that he was biased in thinking that there was some truth in the saying. It was not perhaps that they had too much politics, but that they applied them to too many different things. Sometimes the wrong people were elected. That might be so, and they could only hope that the people would learn wisdom in time. (Laughter.) For they only learned by their mistakes. It seemed to him that the one cure for this so-called curse of politics was that they should have more decentralisation in their government. They should not all look to Parliament for every little thing that they wanted done. They should try to get some real system of local government in South Africa—which at present they had only got the beginnings of—that would deal with the large number of problems that affected the daily life of the people, without going to this overburdened body which sat at Capetown—overburdened not merely by the amount of work that it had to do, but by the fact that it had to accommodate itself to the strategy or tactics of the various Parties of which it was composed. He did not think that even the introduction of the "buzzer," which was expected to work miracles in the House of Assembly, was going to fit Parliament to discharge all the duties which the people of South Africa at present expected of it, therefore they ought to encourage a system of decentralised government by which the social problems, of which they had many, could be dealt with without subjecting them to the delays and postponements and the useless conflicts of the Party spirit. (Applause.) There was a very large number of questions lying at their doors which ought to be dealt with. Questions of indigence, the housing of the people, the neglect of children, unemployment—all, these things they should be able to deal with without introducing the Party spirit which immediately arose when they went to Parliament. He did not say that Party spirit was a bad thing, or that they could do without it, but they could leave Parliament to deal—more than they did now—with the large questions of national policy—whilst for themselves they tackled the problems which immediately affected the lives of the people in the districts to which they belonged. (Hear, hear.) No community could live healthily and well when these things were neglected as they were neglected to-day. And they could only be attended to by relieving Parliament of a large amount of work that to-day it was expected to do. Another thing for South Africa to consider was what they were going to do in that community of nations to which they belonged—he meant as members of the British Empire. The war had brought the members of the Empire together, and kept them together by ties stronger than ever existed before. It seemed to him that these ties, which were forged by the necessities of the war, should not be allowed to rust in times of peace, for he believed that they were capable of doing a great work for the world. He believed that we as a nation, together with the other nations which made up the Empire, could exert that force in the counsels of the world which would make for peace, for reasonable dealing, and the advancement of the interests of humanity in a way they never could exercise if they did not belong to that set of nations. (Hear, hear.) They as a nation had been advanced to a stage which never before was recognised. They were a member of the League of Nations, and he did not believe that any of them, not even their rulers, understood what were the obligations that that entailed or how they were to be carried out. But he did think that it was a task for their Statesmen to say how those ties should be kept alive, not so as to interfere with their freedom as a South African nation, but to enable them to work together in that community and help towards the task of peace and reconcilement, which was the greatest thing before civilised mankind to-day. Civilised mankind was to-day faced with a task that it never had before. It was to build up, out of the wrecks of a war that had destroyed almost everything that went to make up European civilisation. South Africa, as a young nation, should be proud to have a part in that, and it should be the task of its Statesmen to see in what way they could use the ties that the war had created to make that task a success. (Hear, hear.) Now, what they wanted in South Africa to carry out these various things was the greater cultivation of what he might call the South African spirit—to forget that they belonged to one particular section or race or class, and more to remember that they were South Africans. They had differences of every kind, and these differences would be wide and strong, possibly even fierce, but let them always remember that behind them was a unity that they should not disturb, and that behind them remained the fact that they belonged to this young nation, and it was their first duty to see that these differences should not be carried so far as to interfere with their doing their bit and building up that nation. (Hear, hear.) That feeling of sentiment and that spirit of nationality had made great advances in the past, and it was to the development and strengthening of that feeling of nationality that they must look in the future for the advancement of South Africa. It gave him great pleasure in proposing the toast to accompany it with the name of Professor Hofmeyr, who bore a name that already shone in the history of South Africa, and which had done great things for this country, and he was perfectly sure that it had not yet seen the last of its services to South Africa, but that Professor Hofmeyr was going to add to the lustre it already bore. (Cheers.) He thought that they were fortunate in having Professor Hofmeyr at the head of their University. He called it so for want of a better name, though he understood that the powers that were were not even prepared to grant an approach to that title. He could not imagine anything that would confer a greater benefit on the Rand than the development of its educational institutions towards University status. There could be no greater sign or cause of permanence in this population, or anything that would more show the capacity of this population for something more than mere financial enterprise—than the development of a University here, worthy of the place and what it had done for South Africa. In pushing this University here they need not grudge any success that might be attained by similar institutions in the country. That was not the spirit in which those who were promoting it were working, but the best token they could give to the value of the University in Johannesburg was by putting their own shoulders to the wheel. (Applause.)

Professor J. H. Hofmeyr, in responding, expressed his gratitude to the Deputy-Mayor for having very kindly arranged that the trams should not run for that evening at least—(laughter)—for it enabled the company to hold their meeting in comparative quietness. All those whose misfortune it had ever been to speak from that table had always looked forward with dread to having to speak before a censorious audience in front and a succession of noisy trams behind. (Laughter.) They owed it to the Deputy-Mayor that for once they might have peace. He had accepted with a good deal of hesitation the invitation to respond to the toast, as he had felt that it was far too important for him to do adequate justice to it, and that it was particularly difficult for one in his position to speak to a toast of that kind. It happened to be that the toast had become consecrated to politicians or would-be politicians. Mr. Duncan had behind him a distinguished political career. They hoped that it would not be long before he again frequented the House of Assembly. But he (the speaker) had neither a political career behind nor in front of him, and naturally he trembled. He was one of those who were not supposed to have any political views—not even on matters of Municipal politics. If he were that evening to indicate disapproval of the strikers, he supposed that there would be a danger that the University grant would be cut off by the Board of Control, which would shortly supersede the Town Council. (Laughter.) At the same time he much appreciated the honour they had done him in asking him to reply to the toast, and he was particularly glad that he could speak to it as one of the older branch of the South African nation, and in doing so indicate appreciation of the way in which Mr. Duncan—a representative of the other branch—had spoken to it. He thought he might say without fear of contradiction that all sections of the Dutch-speaking population had come to look on Mr. Duncan as one of their best friends, as one who most fully appreciated the sentiments of the Dutch-speaking population, and one who took the most liberal and broad-minded view of their desires and aspirations. And he was particularly pleased that he was able to reply to the toast which had been so eloquently and ably proposed by him. He was glad, too, to notice the way in which the toast had been put forward. Not many years ago the toast would have figured on the toast list as, "The Land We Live In." That was all changed now, and they were thankful to see it. (Hear, hear.) It was one of the small signs of the really great change that had come over South Africa within the last few years—the change in sentiment towards South Africa of the English-speaking section of the population, and he, as representing the Dutch-speaking section welcomed that change. (Hear, hear.) Now he was going to venture to indicate some points which to his mind were necessary with a view to the attainment of the prosperity which they wished this country of their adoption or their birth. The President had already referred to the necessity of more work and less politics, and Mr. Duncan had referred to the necessity of less politics, or rather different form of politics. He would like to endorse what both of them had said. He did feel that one of their greatest needs on the political side at the present moment was that of devolution—of putting more responsibility on their local bodies, and of creating more local bodies, especially in the Northern Provinces, and in that way educating up the country population in particular to their political duties, privileges and responsibilities. He thought that it was one of the weaknesses of their system at present that in the country districts, particularly of the Transvaal and Free State, the people did not yet fully understand what their political privileges were. They still clung to the old traditions, to the Government of a President drinking coffee and smoking his pipe on the stoep—the paternal Government of the old days, and they still looked to somebody—the Prime Minister now, instead of a President—to satisfy their wants. Well of course things had changed, and the people of this country must learn that they could not get everything from the top—that they must undertake more responsibility on their own account, and in the way that Mr. Duncan had indicated that aim would to some extent be attained. On the other hand of course more work was wanted. He supposed there was no feature of the Prime Minister's policy that had won more general commendation than his insistence on the need of our buckling to with a view to the industrial and economic development of this country. Not long ago he (Professor Hofmeyr) was saying to one of his neighbours that one of our great problems to-day was the change-over from mining to industry. Mr. Buckle would say that he did not regard mining as an industry, but his meaning would be clear to them. The days of the almost complete dependence of the country on mining were passing away. They had to replace it, and had to pursue with vigour the policy of industrial and economic development. Might he suggest a second point, and that was that they should have less of the past and more of the future? One of their troubles in this country—and he said it advisedly—was that they had too much of the past, too much of the difficulties of the past, and too much of the differences and causes of grievance in the past. On both sides they dwelled too much on things that had better be forgotten. Some of them might perhaps remember a statement of Sir Horace Plunkett when he said that the history of Ireland was something for England to remember—for Ireland to forget. Well, the history of South Africa, or a great part of it, was something for both the English and Dutch of this country to forget. (Hear, hear.) There were parts of it that they might remember. There were great traditions, and they had great achievements of which they might well be proud, but there was much that was best buried in oblivion. If they would pardon him he would tell a little story which he thought might illustrate his point. A country Magistrate once told of an incident that took place in a town not far from Johannesburg. One day a farmer came to him for advice. It was a particularly difficult situation. He said that on the previous evening he had come home from work, and when he got into the dining-room he found his wife and his overseer sitting on the sofe in affectionate conversation. (Laughter.) So he asked the Magistrate what he was to do. The Magistrate said, "Well, you had better get rid of the overseer." "No," was the reply, "I cannot do that—he is too valuable—my farm would go to pieces." (*He* was not contemplating selling his farm.) "Well," said the Magistrate, "you had better divorce your wife." "But," said the man, "I cannot do that—I cannot do without her." So the Magistrate had to give up the problem as one not admitting of solution. A week or so after that he met the old farmer in the street looking very pleased with himself, and he asked him if he had solved the problem. "Yes," he was told. "Well, how did you do it?" "Oh, I sold the sofa." (Laughter.) Well, there was a good deal of good horse sense in that. The farmer knew that it was not much use keeping alive the grievance which had arisen in his mind. The best thing that could be done was to remove that which would serve to remind him of the difficulties of the past. (Laughter.) And in this country it was our business to sell the sofa of our national disagreements. (Hear, hear.) In that way alone could we work in the direction of building up that sound national feeling of which Mr. Duncan had spoken. And if we were to take our place in the affairs of the world as a whole, then surely we must take our place as a unit, and we must evolve a true South African national feeling as a condition of taking part in international affairs. And let us remember that the South African nationality was not going to be a Dutch nationality or an English nationality. It was going to be a little bit of each, and each section would have to give up something. The third point that he (the speaker) wished to make was this: That one of the things we needed in this country was a little more vision and and imagination—and a little more faith in the country. If one looked back on the history of South Africa during the past century the picture that was sometimes suggested to one's mind was that of a ship trying to reach harbour, but always at the moment of reaching it being caught by a gale from the wrong quarter. At every moment when the goal of Union seemed to be in sight, some unforeseen event occurred to destroy the hopes of those piloting the vessel, but when one looked closer one found that the real difficulty had been the lack of vision on the part of those who had been piloting the ship, and in every case one could find that those responsible had not taken the long view. (Hear, hear.) They were not prepared to neglect the selfish or individual interests of the moment for the sake of the greater good to be obtained in the future, and that was one of the dangers before us at the present time—that many of our politicians and statesmen were not taking the long view and looking far ahead and thinking of the good of the whole with a view to the position in twenty or thirty or forty years' time. And surely, too, we wanted at this stage more faith in this country, and more faith in this community. One of the things from which we had suffered in the past in this community had been the lack of faith of those who had lived here in this town and on the Rand. Many of them had felt that Johannesburg and the Rand were only to have a temporary existence; therefore it was perhaps not worth while spending more money on the development of the permanent institutions of the place, and so they had gone away and not left their money behind them. Well, things were changing, and people were beginning to have more faith in this community. (Hear, hear.) It was only right that they should. It was true that our difficulties at the present moment seemed to be particularly great, but he felt sure that they were only temporary and they were due largely to the fact that this was a time of transition. But a solution was bound to be found. (Hear, hear.) We wanted, too, more faith in our country as a whole. During the last week or so they had been interested in accounts of the debate on the Budget which had been placed before the House of Assembly. And he thought that some of them had been struck by the tone of some of the criticisms. A good many of them would agree with the criticism that the Government had not been sufficiently careful in restricting the growth of expenditure as far as the Civil Service was concerned, but he thought it was very unfortunate that exception should have been taken to the proposal of the Government to expend large sums of money for the development of the country. One feature surely of which they should approve in the financial proposals now laid before Parliament was the proposal to devote a matter of £12,000,000 to works of development. It was only along these lines and showing faith in the great possibilities of the country that the country was likely to develop. Mr. Duncan referred at the close of his speech to the University movement in Johannesburg, and he (Professor Hofmeyr) would like to thank him for the kindly words he used in regard to that. But here, too, it was a case of having faith in the country. If they believed in the future of this Rand area there could be no question that the University, the beginnings of which they saw that day, was destined to a great future, and that it was destined to perform important work for this community and South Africa. And if they did have faith in the future, then they should have no hesitation in giving it their support. To him it was clear that if they were prepared to go forward in the spirit of the speech made by Mr. Duncan, there could surely be no doubt as to the great future which lay before this our country. (Loud applause.)

Mr. H. A. White (*Member of Council*) in proposing the toast, "Our Guests and Kindred Societies," said: Though we have a smaller gathering to-night than has been customary in the past, yet we are to be congratulated on making so good a show after six years' intermission. In the interval since we last met on a similar occasion Peace has followed War, but is not yet in full possession. A less spectacular but even more virulent warfare is still in progress. In this struggle the old protagonists used to be Capital and Labour, but its character is changing and Capital has become the battleground while the principals are, on the one hand, those whose occupation is predominantly mental, and on the other those principally dependent upon the use of their muscles. Up to the present it is the latter who are winning in this internecine strife, and one of the chief reasons why the manual worker is getting more and more of the real power of control of the Governments of the world, and of the industries by which we live, is the development of organisation among them. That is where the mental worker is lacking; inherent individual peculiarities seem to be a bar to that combination which alone can secure for them their rightful position in the world of affairs Any attempt to dispense with trained technical service must result in serious loss, but that wrong attitude was taken up only the other day by the Directorate of the Luipaards Vlei Mine, who boasted of saving the salaries of consulting and mechanical engineers.

Professional and technical men are gradually realising the power of combination, and we now have a local instance. After five years' continuous effort, and by means of the very timely and generous aid offered by the Chamber of Mines, we have now made provision for the establishment of a joint home for the Scientific and Technical Societies of the Rand. It is now the duty of all of us to make every effort required to further the success of that Institution. Among the kindred Societies represented here to-night the Red Cross Society is especially dear to the members of our own and the proof is embodied in the person of our late Secretary, Mr. Fred Rowland, who has followed up his excellent service to them during the war by wholly forsaking us for them and our very best wishes go with him. Our sincerity in drinking the health of our guests and of the kindred societies is best emphasised by inviting each one of you to become one cf us.

Colonel Dalrymple and Dr. Ronald Mackenzie (President of the Witwatersrand Branch of the British Medical Association) responded in happy terms.

Mr. C. F. Stallard proposed the health of the Chairman and President of the Society. The sentiment of less politics and more work, he said, would be carried away by the Deputy Mayor as having been directed to just the right quarter. (Laughter.)

The President suitably responded.

All the toasts were very heartily honoured and the proceedings concluded about 11.15 p.m.

Obituary.

JOHN STEWART MacARTHUR

(Honorary Member).

The members of our Society will learn with much regret that Mr. J. S. MacArthur, whose name is familiar throughout the mining world as the inventor of the cyanide process, has recently died in consequence of complications following upon a chill.

John Stewart MacArthur was the son of a Scotch clergyman and began work early in life as an apprentice in the laboratory of the Tharsis Sulphur and Copper Company of Glasgow. Later he entered the service of the Cassel Gold Extracting Company as chemist (1871-86), eventually becoming its technical manager (1886-93), and subsequently managing director until 1897. It was during his service with this Company that he, in concert with Dr. Forrest and others, undertook during his leisure hours the series of systematic researches for a hydro-metallurgical process of lixiviating gold ores, which resulted in the first practical application of a dilute alkaline cyanide solution as a gold solvent, and of zinc shavings, at first plain and later lead-coated,* as a precipitant of the dissolved gold.

Apart from patent specifications, the first published authoritative account of the MacArthur-Forrest process of gold extraction is contained in an article published by J. S. MacArthur in the *Journal of the Society of Chemical Industry* on 31st March, 1890. After describing the practical application of the process, the paper concludes with the following words:—

> "I confidently predict that cyanide of potassium hitherto used only to polish amalgamated plates, will take front rank as chief agent in gold extraction."

The events of the last thirty years have amply fulfilled this prediction, and further, most silver ores in Mexico, which is the chief source of silver, have for years been treated by means of the cyanide process. The many million ounces of gold and silver yearly extracted by means of the cyanide process have, apart from their direct influence upon the mining industry, produced wide and far-reaching effects upon the whole monetary and economic systems of the civilised world.

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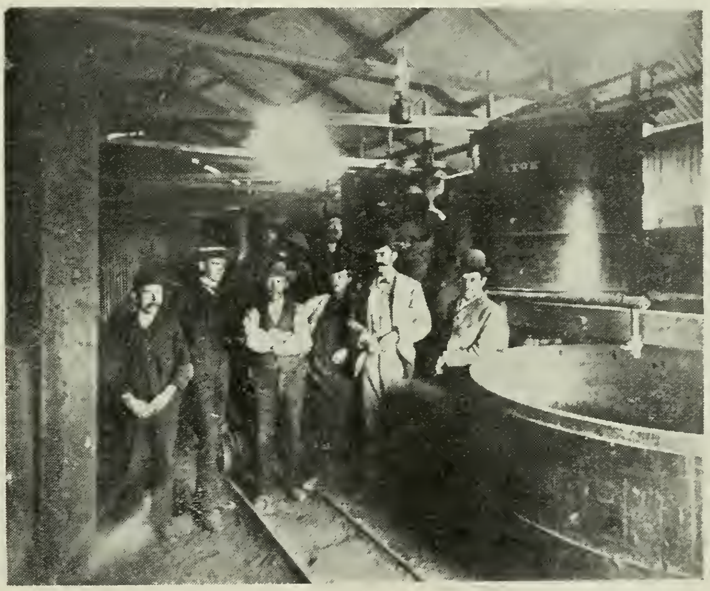
* This *Journal*, Vol. II., p. 915.

The cyanide process was demonstrated in South Africa upon a variety of gold ores, concentrates and tailings in 1890 at the battery of the Salisbury G.M. Co., and the accompanying illustration, due to Mr. Alfred James, shows J. S. MacArthur amongst the members of the staff, and also the diminutive size of the vats employed. Later, this pioneer work of the Cassel G.E. Co. was taken over by the African Gold Recovery Syndicate, which eventually became the African Gold Recovery Company. Following these novel and successful demonstrations the use of the process rapidly extended in the Transvaal and the whole mining world, as its superiority over competitive methods became realized. To the gold mines it meant the conversion of embarrassing tailings into dividends, and the payability of mines otherwise unprofitable. Some of MacArthur's reminiscences of this period were given in the December, 1908, issue of our *Journal*.

Subsequently in 1896 the Transvaal patents were the subject of an historical law-suit, which resulted in their cancellation on the ground of prior scientific knowledge, although no gold had ever been previously extracted on a commercial basis from ores by means of cyanide solution. A recent tribute to MacArthur's work in this direction is contained in Dr. H. H. Green's Presidential Address before the last meeting of the South African Association for the Advancement of Science in the following words:—

> "Thus the development of the whole mining industry of the Witwatersrand, and the very coming into existence of the city of Johannesburg, was conditioned by a laboratory observation made originally by a pure chemist, and developed by a mineralogical chemist—who, it may be added, did not get enough out of his patent to enable him to abandon his practice. The cyanide process for the extraction of gold from low-grade ores and tailings makes just that difference between profitable and unprofitable production of gold in South Africa, and without it the industries of the Witwatersrand would never have reached their present development."

Following on the last of his visits to the Rand, MacArthur engaged for many years in ordinary professional work on gold and copper as a consulting metallurgist. His practice involved repeated visits to Portgual



A GLANCE AT THE PAST.
The Salisbury Demonstration Plant in 1890.
Messrs. Titmus, Caldecott, Inglis, Mason, Alexander, MacArthur and James.

and the United States as well as numerous investigations and researches. In January, 1913, he published a paper in our *Journal* on zinc wafer precipitation, and during the war until his death he devoted himself to the extraction of radium at Balloch on Loch Lomond for military watches and compasses.[†]

To his sturdy independent Scottish characteristics and chemical knowledge, MacArthur added a remarkable insight and tenacity of purpose and a kindly consideration for those with whom he was associated. The world is the poorer through his death in the loss of a good chemist, a famous inventor, and an honourable, upright man.

In addition to having been for many years an Honorary Member of our Society, MacArthur was awarded in 1902 the Gold Medal of the Institution of Mining and Metallurgy, and the well-known text-book "Rand Metallurgical Practice" was dedicated to him by the authors in the following terms:—

TO
JOHN STEWART MACARTHUR,
Whose Pioneer Researches and Introduction in 1890
of the Cyanide Process
as an Essential Feature of
Rand Metallurgical Practice
have Rendered Possible the Successful Treatment
on Scientific Principles of Low-grade Banket Ore,
and have been a Prime Factor in Establishing
the Witwatersrand Goldfields
as the Premier Gold Producer of the World.

(W. A. C.).

Notices and Abstracts of Articles and Papers.

CHEMISTRY

VOLUMETRIC SCIENTIFIC GLASSWARE. The manufacture of volumetric scientific glassware, such as burettes, pipettes, etc., is an industry which was practically non-existent in this country before the war. During the war the industry was largely developed here, and it is most desirable that it should remain as a permanent British asset. To attain this, an all important factor is that British made graduated apparatus should be of reliable accuracy. Volumetric glassware has been tested on a small scale at the National Physical Laboratory for the past 15 years, but with the growth of the industry it was felt that the scope of the work should be widened. Consequently, in co-operation with manufacturers and users of scientific glassware a pamphlet was issued in July, 1918, containing regulations relating to Class A tests, *i.e.*, tests on apparatus required to be of the highest accuracy. A new building has just been completed at the Laboratory specially equipped for dealing with this class of work on a large scale. At the outset it was urged that in addition to the tests already referred to, provision should be made for testing apparatus intended to possess only commercial or Class B accuracy. Pending the settlement of a permanent scheme for commercial testing by State or State-approved institutions, a matter which is now under the consideration of the Government, the National Physical Laboratory is now prepared to undertake Class B tests at the request of manufacturers and others, such tests being carried out for the time being at Teddington. It is hoped eventually to arrange for this work to be done at local centres. The Class A tests are designed for vessels intended to possess the highest accuracy required for scientific use, but the limits of error assigned for the Class B tests are such as all graduated apparatus of good commercial quality should comply with, and are necessary for the attainment of satisfactory results in ordinary routine analysis. A full account of the tolerances allowed, methods of tests, details of construction, test fees, etc., is given in the new edition of the Laboratory's test pamphlet relating to "Volumetric Tests on Scientific Glassware," issued in November, 1919, and superseding the older edition. Copies of the pamphlet, which was drawn up in co-operation with both manufactures and users of volumetric apparatus, may be obtained free of charge on application to the Director, The National Physical Laboratory, Teddington, Middlesex.—*Iron and Coal Trades Review*, February 6, 1920, p. 181. (J. A. W.)

COMPOSITION OF THE PRECIPITATE PRODUCED IN THE PREPARATION OF STRIEGLER'S REAGENT [FOR REMOVING EXCESS OF LEAD FROM CLARIFIED MOLASSES].—Previous to determining the reducing sugars in cane molasses, it is generally necessary to clarify with lead acetate, the excess of the reagent beiog removed by the addition of a suitable salt. Striegler's reagent (Tervooren's "Handboek," p. 341), which is used in Java for removing the excess of lead after clarifyig molasses with lead acetate, is prepared by dissolving 25 grms. of oxalic acid in 250 cc. of water, neutralising with sodium carbonate, making up to 500 cc., and filtering off the precipitate formed. Tervoreen states that this precipitate is sodium bicarbonate, but experiments carried out by the author show that when sodium carbonate is added to oxalic acid under the conditions specified, two precipitates are successively formed, first, sodium binoxalate, which re-dissolves on continuing the addition of sodium carbonate, and, second, sodium oxalate, part of which later dissolves on making up the liquid to 500 cc., with water. It is concluded that the reagent consists of a saturated solution of normal sodium oxalate, containing a small quantity of carbonate.—G. P. BROUWER, *Jour. Soc. Chem. Ind.*, May 15, 1919, p. 298 A. (A. W.)

PREPARATION OF CUPRIC-SODIUM HYDROXIDE REAGENT, FOR USE IN THE DETECTION AND DETERMINATION OF SUGARS.—A reagent, which may be used in place of Fehling's solution, is prepared by adding 20 cc. of 10% copper sulphate solution slowly to 100 cc. of 33·69% sodium hydroxide solution. This solution remains clear when kept, and does not give a precipitate of cupric oxide when boiled.—E. JUSTIN MUELLER, *Jour. Soc. Chem. Ind.*, p. 298 A. (A. W.)

[†] *The Scotsman*, 18th March, 1915.

METALLURGY

Iron Industry in Rhodesia.—After reviewing the ore occurrences, the author says that whatever the situation as regards ore supplies, everything points to the country between the Sabi and Lundi Rovers as the best site for blast furnaces. Coal is available in large quantities over a wide area; some of this is of poor quality, but there is at least one section of the coalfield which has been shown to furnish excellent coal. It has other advantages in the fact that native labour is abundant and that cattle live and thrive, which is an important consideration as regards conditions of living for white men. All the northern part of Mashonaland is placed out of the running by the fact that there is no coal between the ore deposits and the sea along any direct railway route. The Sabi area, on the other hand, is about as near the coast as one can get without going outside Rhodesian territory, and all experience shows that it is better to smelt where the coal is obtained than to bring coal to the iron mines. Even if the ore close at hand proves of inferior quality, it could be economically brought to the smelters even from the farthest off of the deposits.—F. P. Mennell, *Iron and Coal Trades' Review*, April 2, 1920, p. 462. (J. A. W.)

Iron Ore, Rustenberg.—Hæmatite iron ore is to be found in the Rustenburg district on the Pretoria-Pietersburg Railway. The ore can be classed as a variety of sedimentary iron ore, forming part of the succession of the Timeball Hill series, in which the proportion of hæmatite has been enormously increased, so as to form solid masses of ore, yards thick, as compared with fractions of an inch elsewhere. It carries about 63·3 per cent. of metallic iron with about 0·1 per cent. of titanium and chromium, 0·05 per cent. of P_2O_5, but no sulphur. The collective thickness of the solid bands of hæmatite amounts to 42 ft., exclusive of 5 ft. of intercalated silicious calico rock (thin bands of silica ½ in. thick and less alternating with thin layers of hæmatite often only ¼ to ⅛ in. thick). The latter is quite distinct in appearance from the hæmatite bands, and hence readily amenable to sorting.—*Iron and Coal Trades Review*, March 26, 1920, p. 419. (J. A. W.)

MINING.

Volatilization in Assaying.—It is common to blame irregular assay results upon volatilization and much has been written upon the subject, but there is no real evidence that, in a properly conducted assay, the loss of either gold or silver by volatilization is sufficient to affect appreciably the result, even when arsenic or antimony may be present. Bulk assays of flue dust from assay muffles have been published, but the data given are totally insufficient to even approximate the volatilization from a single assay; and such figures as we have indicate the volatilization to be extremely small. Diligent search in the literature and wide inquiry among assayers and instructors have failed to produce a single case where the litharge volatilized in making an assay has been collected and assayed for gold and silver. Having attempted to do this, with most indifferent success, I am not surprised that this has not been done.

While various text books give volatilization as a cause of loss in cupellation, it may safely be said that in the rare cases where this volatilization is sufficient to affect appreciably the result it is due to excessive temperature. Percy says, "The loss of silver by volatilization during cupellation is very slight (unless the temperature has been much too high), and may be disregarded." This statement is repeated by the Beringer and Smith, who include gold with silver. Mitchell says the litharge fume rarely contains over one ten-thousandth of silver. Campredon says that at a proper temperature no silver is lost by volatilization.

Primarily, excessive temperature may be due to too high general temperature in the muffle; but it may often be due to temperature localized within the bead by oxidation of the metals and this may be influenced by other causes than the general temperature. I have shown an extreme case of local temperature, resulting in the burning of zinc with its characteristic flame and variations in bead temperatures with uniform pyrometer readings. Volatilization from a bath of mixed metals is not the simple question of vapour pressures of the contained metals. Based entirely upon vapour pressures, Richards, in speaking of the distillation of zinc from Parkes crust, says, "Successively larger amounts of lead, silver, and gold come over the higher the temperature," but I have shown that more silver goes with the zinc in the early stages of the operation than later.

The possible volatilization of the precious metals in cupelling is a most complex proposition. It may be due to the vapour pressure of the individual metals, the vapour pressure of alloys or possible metallic compounds, of metals with metalloids or with non-metals, particularly oxygen.

Many statements regarding volatilization in assaying are based upon data obtained under conditions entirely different from cupelling and much that has been written fails to distinguish between volatilization and dustng, which is purely mechanical. In practical operations, losses are often ascribed to volatilization that are largely, if not entirely, due to dusting and other mechanical causes.

Various persons have reported the finding of gold and silver in the fumes condensed in the flues or muffles, but these generally show only minute quantities of the precious metals and all lack quantitative significance.—Frederick P. Dewey. *Mining and Metallurgy*, February, 1920. (W. A. C.)

MISCELLANEOUS.

Gibbs' Breathing Apparatus.—During the year the Bureau of Mines continued tests of the new breathing apparatus designed by Mr. W. E. Gibbs, engineer of mine-safety investigations, which differs from the Fleuss and the Dræger apparatus in the following three distinct features:—(1) Control of the oxygen supplied to the wearer, (2) arrangement of the alkali absorbent used to remove carbon dioxide from the exhaled air, and (3) the prevention of excessive heating from the reaction between the carbon dioxide and the alkali. The rate of oxygen supply is controlled by the wearer's breathing, and, as tests have shown, readily adjusts itself to his needs, either at rest, when the consumption is about from 300 to 400 cubic cm. a minute, or during vigorous breathing, when it is between 2,000 and 3,000 cubic cm. a minute. Pending extended use of the apparatus under practical conditions in entering mines after explosions and fires, its use has been tentatively approved by the Bureau; thus it has been placed officially on the same footing as the Fleuss and the Dræger. In two mine fires and in one disaster the Gibbs' apparatus met all requirements. Fifteen tests were made with it, eight of which were during a period of more than two hours of strenuous work, to determine the functioning and the tightness of the apparatus. The remaining seven tests were for determining efficiency of the regenerative cartridge. All results were satisfactory; only a little carbon dioxide, usually less than 1 per cent., was present in the air supplied the wearer. Sixty-five sets of Gibbs' apparatus have been received by the Bureau. These, after being tested for tightness and proper functioning, and after their record is taken, are being distributed to the rescue cars and stations.—*Indian Engineering*, Nov. 29th, 1919, p. 303. (J. A. W.)

Abstract of Patent Applications.

160.19. G. A. Sheeley. Improvements in lining for tube mills and the like. 7.3.19.

This application relates to improvements in tube mill liners of the "Osborn" type, and consist in providing grooves in the radial bars and corresponding projections in the flat bars, in order to facilitate the placing of the bars, as well as securely locking them in position.

Various shapes of bars are shown, applicable to this application, as well as provision for at least one bar in each section to be made of cast iron or other fragile metal, which is further weakened by having holes or grooves to allow of being easily broken and removed wherever it is desirable to renew the lining.

258.19. J. P. Cloete. Improvements in apparatus grading comminuted or crushed material. 10.4.9.

This application relates to an improved apparatus for screening material such as ground quartz, etc., and consists of a revolving screen arranged to receive the crushed material on the outside and falling within, wherein it differs from the common practice of feeding inside and allowing the screened material to pass through to the outside.

The advantages claimed are that this enables the full length of the screen to be utilised, with less wear or liability to become choked.

Various details are described, such as shape and construction of screen, methods of driving and provision for washing the screen by passing through water in a trough on the lower side.

Book Reviews.

Manganese Ores. By A. H. Curtis. Tin Ores. By G. M. Davies. London: John Murray, Albemarle Street, W. (3s. 6d. net each).

Both these publications are monographs issued under the auspices of the Imperial Institute in their Series "Monographs on Mineral Resources, with special reference to the British Empire." A third on "Tungsten Ores," is to follow shortly. Both parts under review have been written on the same plan. The ores, their occurrence, character, and uses are dealt with first, followed by detailed description of the sources of supply (a) within the British Empire, and (b) in foreign countries. There is a short bibliography on the subject at the end of each volume. *Iron and Coal Trades' Review*, February 6, 1920, p. 188. (J. A. W.)

The A.B.C. of Iron and Steel. Edited by A. O. Backert. The Penton Publishing Company, Cleveland, Ohio (U.S.A.). (Price $5 per copy, post paid.)

This is the third edtion of a book which aims at describing accurately and completely, but in an interesting and non-technical way, every step in the manufacture of iron and steel from the ore to the finished product. It is not intended for the technical specialist, but for the busy, practical man who wants to have a broad, general knowledge of the whole industry. To make everything clear and understandable, over two hundred photographs of iron and steel mill operations and equipment have been added. The subject is dealt with in 23 chapters, and it is claimed that every one of the 16 authors is a recognised authority on the particular branch about which he writes. Besides the explanatory text the volume includes what is intended to be a complete directory of all the blast furnaces, steel works, and rolling mills in the United States and Canada. The first section of the directory is an alphabetically arranged list of all these plants, with the address, the products, and the names of the officials listed under the name of each plant, while in the second section the firms are classified according to their products, every plant being listed under the name of every article it turns out. *Iron and Coal Trades' Review*, February 6, 1920, p. 188. (J. A. W.)

Changes of Address.

Ball, Major H. Standish, O.B.E., c/o Standard Bank of South Africa, Ltd., 10 Clement's Lane, London, E.C.

Boydell, H. C., *l/o* London: Massachusetts Institute of Technology, Cambridge, Mass., U.S.A.

Filet, G., *l/o* The Hague: Kapteijn Street, Hospital Hill, Johannesburg.

Forrest, B. C., *l/o* Roodepoort: P.O. Box 6973, Johannesburg.

Hubbard, A., *l/o* Langlaagte: 80, Newland's Avenue, Benoni.

Jennings, S. J., *l/o* Broadway, New York: 11, East Eightieth Street, New York City, U.S.A.

Proft, W. M., *l/o* Leonie, Dist. Pretoria: Lutzputs, via Upington, C.P.

Redfern, A., *l/o* Uitkyk Collieries: Grenfell Colliery Co., Ltd., P.O. Box 110, Ermelo.

Tayler, W. A. C., from Active Service: Sub-Nigel, P.O. Box 50, Nigel.

Waters, W., *l/o* Johannesburg: Cranbrook, Heene Road, Worthing, Sussex, England.

Wilson, J. C., *l/o* Rooiberg: P.O. Box 35, Messina, Transvaal.

Wood, A. A., *l/o* Millsite: Van Ryn Deep, Ltd., P.O. Box 225, Benoni.

Corrigendum.

Changes of Address, April, 1920.

For G. Melville read G. Melvill.

THE JOURNAL

OF THE

Chemical, Metallurgical and Mining Society

OF SOUTH AFRICA.

The Society, as a body, is not responsible for the statements and opinions advanced in any of its publications.

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Vol. XX. JUNE, 1920. No. 12.

Proceedings

AT

Special General Meeting, June 26, 1920.

A Special General Meeting of the Society was held in the South African School of Mines Building, Johannesburg, on Saturday, 26th June, 1920, Mr. Jas. Gray (President), in the chair. There were present:—

24 Members:—Messrs. J. Chilton, G. A. Watermeyer, J. R. Thurlow, H. R. Adam, C. J. Gray, A. King, J. J. R. Smythe, F. W. Watson, H. A. White, Prof. J. A. Wilkinson (Members of Council), W. Beaver, P. Friedman, L. D. Hingle, H. Rose Martin, P. T. Morrisby, S. Newton, A. E. Pulford, W. S. V. Price, J. Thorlund, W. E. Thorpe, John Watson, H. R. S. Wilkes, L. B. Wilmot and J. A. Woodburn.

3 Associates:—Messrs. E. G. Bilse, J. A. Boyd, and J. Gibson. Mr. F. Rowland (late Secretary) and H. A. G. Jeffreys (Secretary).

The President: This Special General Meeting has been called for the purpose of considering resolutions in connection with the proposed alteration to the Constitution and Rules of the Society in order to define the purposes and regulate the disposal of the "Research Endowment Fund" which is now being established. At the last meeting of the Society the Research Endowment Scheme was outlined, and you gave authority for the alteration of the Society's Constitution and Bye-Laws, which we propose to do to-night. I will call upon Prof. Wilkinson to move the resolution.

Prof. J. A. Wilkinson *(Past-President)*: Before moving the resolution, I will read Clause 34 as it stands at present:—

> "All funds, property, and assets of the "Society shall be vested in the Council for "the time being in trust for members of the "Society. The Treasurer shall administer the "funds of the Society in accordance with the "directions of the Council, to whom he shall "be responsible."

The following is the resolution which I beg to move:—

> "That the words 'Save as hereinafter pro-"vided' be inserted at the beginning of Clause "34, and that the following paragraph be and "it is hereby added at the end of Clause 34 "of the Society's Constitution and Rules:—
>
> "All donations received or that may here-"after be received towards the fund for pro-"viding prizes for papers, shall be held by "the Society as a Special Trust Account to "be known as the 'Research Endowment "Fund,' the moneys to be invested in the "name of the Society in the Union Govern-"ment Stocks or Loans, Union Municipal "Stocks, or any such securities as are "commonly known as the 'Trustee Stocks,' "the yearly revenue from which shall be "devoted to the following objects:—
>
> "(a) Providing medals or other prizes as the Council may direct for the best paper or papers read before the Society during the year.
>
> "(b) Providing moneys which may be directed to research workers for the provision and to defray the cost of the apparatus or other material necessary for the conduct of research, such apparatus to revert to the Society or otherwise as determined by the Council.
>
> "(c) Providing any other means whereby research in connection with chemistry, metallurgy, and mining may be stimulated and encouraged."

Mr. H. A. White *(Member of Council)*: There is one little point which I should like to have cleared up by Prof. Wilkinson. As the rule reads at present, apparently the yearly revenue must be expended in the year in which it is received; it cannot be held over and added to the General Fund. I do not know whether that matter has been studied, and if so, could he give us some light on it?

Prof. J. A. Wilkinson: This point was discussed, and it was decided if in any year there is no paper, or research work to benefit from the fund, then the interest that accrues shall be paid into the capital fund.

Mr. H. A. White: If you did so, according to present rules you would be acting *ultra vires*

Prof. J. A. Wilkinson: I am quite willing a clause should be put in, in fact, I regret the oversight, as I feel sure we are all quite agreed on that point.

The President: We agreed to that at the last meeting.

Prof. J. A. Wilkinson: If members agree to this amendment, I will undertake to make it quite clear in that respect and to move the resolution on those lines.

Mr. H. A. White: In that case I have pleasure in seconding the resolution.

Declared carried unanimously.

The President: We have to elect Trustees in connection with this alteration of Clause 34. I would move that Mr. Alex. Aiken, of Messrs. Alex. Aiken and Carter, Hon. Auditors and Mr. R. T. Ford, of Messrs. Van Hulsteyn, Feltham and Ford, Hon Legal Advisers, be elected as Trustees.

Mr. John Watson *(Member)* seconded.

Declared carried unanimously.

Proceedings
AT
24th Annual General Meeting, June 26, 1920.

The Twenty-fourth Annual General Meeting of the Society was held immediately after the Special General Meeting, Mr. Jas. Gray (President) in the chair.

MINUTES.

The Minutes of the Ordinary General Meeting, held on 15th May, 1920, as recorded in the May *Journal*, were confirmed.

NEW MEMBERS.

Messrs. John Watson and G. A. Watermeyer having been elected as scrutineers in connection with the ballot for the election of new members, the following were declared unanimously elected:—

Ray, Laurance Gilbert, P.O. Box 1072, Johannesburg. Asst. Inspector of Mines.
Richardson, James, Witwatersrand G.M. Co., Ltd., P.O. Box 1, Knights. Mine Manager.
Winckworth, Lewis, Modder "B" G.M. Co., Ltd., Modder Bee. Shift Boss, Reduction Works.

The Secretary notified that Messrs. Herbert Richard Edmands and William Horton Fletcher had been admitted by the Council as Associates.

RESEARCH ENDOWMENT FUND.

The President: In connection with the Research Endowment Fund I have to announce that we have received a cheque for 100 guineas from the Central Mining and Investment Corporation, Ltd., which now makes a total of £261 15s. 11d. I may state—it has not been announced before—that we have also received 100 guineas from De Beers Explosive Works, 25 guineas from the New Transvaal Chemical Company, and £25 from the B.S.A. Explosive Company. It is obvious there are several firms yet to be approached. The letter covering the donation from the Central Mining and Investment Corporation, Ltd., says, *inter alia*:

> "With the objects for which this Fund is "being established we are entirely in agree-"ment, and we sincerely trust that your "efforts towards its establishment on a satis-"factory basis will be successful."

We are very grateful to these donors, and we hope the fund will do all we anticipate it will do.

JOINT HOUSING.

The Joint Housing Fund at present stands at £203 18s. which, together with the £150 donated from the Society's funds, brings the total to £353 18s. The average contribution per member is approximately four guineas. We know there are a large number of members still to contribute—in fact, we have only received 37 contributions. The cause is a good one. I hope that at the next meeting, in September, my successor will be able to announce a considerably larger amount.

ANNUAL REPORT OF COUNCIL.

The President: I will now ask the Secretary to read the Annual Report. The balance sheet has been distributed to you.

The Secretary: The following is the Report upon the work of the Society during the past year submitted by your Council:—

Accounts.—In the statement now before you it will be observed that there has been an improvement in the revenue side of the account as compared with the previous year. The increased recovery of subscriptions under all heads has been very satisfactory, taking into consideration the difficult period through which we are now passing.

On the other hand the expenditure has been heavy, and includes the Society's donation of £150 to the Associated Scientific and Technical Societies of South Africa. Extra demands which have been made in respect of the salaries of the Society's officials, and the increased cost of printing and stationery are chiefly responsible for the excess of expenditure over revenue appearing in the accounts for the past year, amounting to £265 14s. 2d.

Though the nett revenue from advertisements in the Society's *Journal* was £103 more than in 1918-19, this has been more than counter-balanced by the enhanced cost of production.

Membership.—Twenty-eight new Members have been elected during the year under review, and eight Associates. Six Students also have been admitted. Eleven Members and eleven Associates have resigned, and your Council records with sincere regret the deaths of the following:—

Hon. Member.—John Stuart MacArthur.

Members.—Dr. J. Loevy (Past President), R. C. Boyes, A. L. Edwards, D. M. Ferguson, C. D. Leslie, Dr. Donald Macaulay, O.B.E., M. T. Murray, and G. C. Paterson.

Associates.—B. A. Johnson and W. A. Poynton (on Active Service), A. H. Brown, W. Gallant and F. A. Marriott.

During the last five years, owing to the lack of information regarding the whereabouts and movements of Members and Associates consequent on the war, no action has been taken in regard to subscriptions in arrear, as your Councils have feared that injustice might be done to many who, through circumstances beyond their control, had been unable to keep up their active interest in the Society. In consequence, the published lists of Members for the last three years has been somewhat inflated. Your present Council has, however, decided that the time has now arrived when it is desirable to determine the actual position of the Membership roll, and it has been found necessary to strike off the names of sixty-three Members and sixty-eight Associates of whom all trace had been lost, while the remainder have been classified as doubtful and active, as set forth in the appended table. Your Council considers that the policy of the Society should be to entertain in the most favourable manner, applications for reinstatement from Members who may have been struck off the rolls, and also to remit a portion or the whole of their arrear subscriptions should this be justified by the circumstances.

	June, 1897	June, 1898	June, 1899	June, 1902	June, 1903	June, 1904	June, 1905	June, 1906	June, 1907	June, 1908	June, 1909	June, 1910	June, 1911	June, 1912	June, 1913	June, 1914	June, 1915	June, 1916	June, 1917	June, 1918	June, 1919	June, 1920. On Roll.	June, 1920. In Arrears & Doubtful	June, 1920. Total Active Members.
Hon. Members	5	8	14	9	13	18	18	16	17	18	21	22	20	23	25	25	26	26	25	23	22	21	—	21
Life Members	1	1	1	1	1	2	3	4	7	7	8	9	9	9	10	10	10	9	9	9	9	10	—	10
Members	101	197	281	291	441	639	680	680	683	618	630	731	711	733	618	550	481	463	454	469	463	403	63	340
Associates	—	180	238	243	281	338	321	314	342	357	342	402	380	442	396	351	287	272	263	270	270	205	27	178
Students	—	—	—	—	—	4	8	4	7	18	20	60	57	22	21	15	2	3	5	2	2	6	—	6
	107	386	534	544	736	1,001	1,030	1,018	1,056	1,018	1,021	1,224	1,177	1,229	1,070	951	806	773	756	773	766	645	90	555

Roll of Honour.—It is proposed to close this list with the expiring year, and to publish at an early date a complete Roll of all Members who have taken part in the Great War, as an integral part of the *Journal.*

War Memorial.—On the suggestion of the Joint Committee on Closer Union and Joint Housing, it was decided by the Committee which you elected at the Ordinary General Meeting on 20th September, 1919, to leave this matter for their consideration, in order that joint action might be taken in the matter if a suitable home could be obtained for the Societies.

Papers and Journals.—Papers and contributions and the ensuing discussions have continued to be of a high standard as is evidenced by the interest in the Society's Journal taken by contemporaries. The following original papers have been published during the year:—

July, 1919.—"The Solubility of Gold in Cyanide Solutions," by Mr. H. A. White.

August, 1919.—"Gold—Zinc—Cyanide," by Mr. W. R. Feldtmann.

September, 1919.—The President's Address, "The Position of the Chemist in South Africa," by Mr. Jas. Gray, F.I.C.

"Bwana M'Kubwa Copper Mine, Northern Rhodesia," by Mr. E. M. Weston.

October, 1919.—"A General Review of the Economic Results attending the Gold and Base Metal Mining in the Pretoria Inspectorate during the period 1904 to 1914," by Mr. T. G. Trevor.

"Hanging Wall Support on the Far East Rand," by Mr. L. W. Macer.

November, 1919.—"Some Possible Causes of Discrepancies between Mine and Buyers' Weights of Gold Bars," by Mr. H. R. S. Wilkes.

December, 1919.—"The Solubility of Zinc in Cyanide Solutions," by Mr. H. A. White.

January, 1920.—"An Unusual Process in the Treatment of Gold Ore," by Mr. L. B. Gardiner, B.Sc.

February, 1920.—"Can Amalgamation be Dispensed With?" by Mr. E. M. Weston.

"Means adopted on the New Goch Gold Mine for reducing the Consumption of Mercury," by Mr. H. J. Lee.

March, 1920.—"Some Suggestions on Irrigation," by Mr. A. Baguley, B.Sc., F.I.C.

April, 1920.—"The Identification of Quartz Particles in Konimeter Samples," by Dr. A. W. Rogers, F.R.S.

"Notes on Routine Assaying at the Globe and Phœnix Mine, Southern Rhodesia," by Mr H. R. Edmands.

"Mercurial Poisoning," by Dr. A. J. Orenstein, C.M.G.

May, 1920.—"The Gold Premium," by Mr S. Evans.

Grants.—Grants for prizes have been made to the Students of the Government Miners' Training School and to the evening class students of the South African School of Mines and Technology, while the usual donation has been made to the Seymour Memorial Library.

Closer Working and Joint Housing of Scientific and Technical Societies.—Very great progress has been made in connection with this scheme. The efforts of the Joint Committee, generously aided by the Transvaal Chamber of Mines have resulted in the acquisition of an eminently suitable building, and the formation of "The Associated Scientific and Technical Societies of South Africa," of which your Society and those others which have participated actively in the Joint Housing movement, are foundation Members. A full report of the proceedings in this connection appeared in the *Journal* for April last.

Mr. Percy Cazalet has been elected first President of the Associated Societies, and the Inaugural Meeting, held in the new home on the 12th of June, was enthusiastically supported by an attendance of about four hundred.

Research Endowment Fund.—This Fund is now being established for the encouragement of research in connection with Chemistry, Mining and Metallurgy, and four generous donations have been received up to date. It has been decided that these monies should form the nucleus of a perpetual fund, the revenue from which will provide grants and prizes to research workers. This has necessitated an amendment of the Constitution and Rules of the Society, which was the purpose of the Special General Meeting this evening.

Training of Returned Soldiers and Phthisis Men as Prospectors.—Your Council has been in communication with the Minister of Mines and Industries with the object of obtaining the assistance of the Government in the furtherance of this object. A syllabus has been arranged by the South African School of Mines and Technology, and your Council is advised that the Commissioner for Returned Soldiers is in correspondence with the Secretary, Governor-General's Fund regarding the provision of the necessary funds.

Mining Exhibition.—The Fourth Mining Exhibition of the Society was held in the Assembly Hall, South African School of Mines and Technology, from the 21st to 31st January, 1920. The Exhibition which was on a smaller scale than our previous effort was opened by His Excellency, the

Governor-General, Viscount Buxton. Full particulars appeared in the February *Journal*. The Society is indebted to the Chamber of Mines for meeting the expenses in connection with the Exhibition.

Annual Dinner.—After an interval of six years the Annual Dinner of the Society has been resumed, and a very pleasant gatherng took place at the Carlton Hotel on the evening of Saturday, the 8th May. It is to be regretted that the number of guests was smaller than in pre-war days, but it is hoped that in future the function will become as popular as of yore. A full report of the Dinner appeared in the May *Journal*.

Council.—Ten Meetings of the Council have been held during the year as well as several Committee Meetings. The attendance at the Council averaged ten to eleven, and were as follows:—

Jas. Gray ...	... 10	J. J. R. Smythe	... 8
J. Chilton ...	... 10	T. G. Trevor[4]	... 1
G. A. Watermeyer	... 7	F. W. Watson[5]	... 5
A. Whitby	... —	F. Wartenweiler[6]	... 6
J. R. Thurlow	... 8	E. M. Weston[7]	... 1
H. R. Adam	... 3	H. A. White	... 6
R. A. Cooper	... 4	*W. R. Dowling	... 2
C. J. Gray	... 8	*H. S. Meyer	... 3
C. H. Greathead[1]	... 2	*S. H. Pearce	... 3
H. C. Hilton[2]	... 1	*J. E. Thomas	... 1
J. H. Johnson	... 7	*J. A. Wilkinson	... 4
A. King[3] ...	... 5		

Leave of absence granted for: (1) three meetings; (2) resigned, Nov., 1819; (3) five meetings; (4) elected Feb., 1920; (5) five meetings; (6) two meetings; (7) ill-health.
* Past President.

The Council regrets the loss of the services of Mr. H. C. Hilton owing to ill-health.

The Council desires to place on record its appreciation of the services rendered by the Hon. Auditors and Hon. Legal Advisers, and also by the following Committees:—Finance: Messrs. J. R. Thurlow, Jas. Gray, G. A. Watermeyer and J. J. R. Smythe. Editorial: The President, Messrs. J. Chilton, A. Whitby, H. R. Adam, C. J. Gray, C. H. Greathead, Dr. J. Moir and H. A. White. Mining Exhibition: The President, Messrs. J. Chilton, J. R. Thurlow, F. Wartenweiler, A. Whitby and H. S. Meyer. War Memorial: The President, Messrs. H. A. White, A. McA. Johnson, W. R. Dowling, Prof. J. A. Wilkinson, Lt.-Col. E. Pam, O.B.E., and H. A. Read. Annual Dinner: The President, Messrs. H. S. Meyer and S. H. Pearce, and also to their representatives on the Joint Housing Committee, Mr. H. S. Meyer and Prof. J. A. Wilkinson. It may be here mentioned that Prof. Wilkinson, who has served on this Committee since its inception, originally broached the question of 'Closer Union' at a Council meeting of this Society so far back as March, 1911. The Council has also to record the loss of the services of Mr. F. Rowland after having fulfilled the position of Secretary to the Society for twenty-three years. Mr. Rowland resigned in order to give full time and attention to the Secretarial duties of the South African Red Cross Society. In his place Capt. H. A. G. Jeffreys, O.B.E., was appointed Secretary to the Society, and he took up his official duties on the 1st March.

The President: In moving the adoption of the Annual Report and Financial Statement, I desire to draw attention to a few of the more outstanding points in connection with the year's work.

The most satisfactory feature is the consummation of the hopes and aspirations of the Scientific and Technical Societies of South Africa in having successfully obtained a Joint Home. The suitability of the building must have been apparent to those who were present at the inaugural meeting held recently in the premises for the purpose of enabling members to become acquainted with their new domicile. I anticipate that the future of the Associated Societies is one which must be productive of good not only to the members of the interested societies but to the country at large. The donations which have already been given towards the scheme in response to the appeal by members and associates of this Society have so far been extremely generous. I hope that those who have still to contribute will do so as soon as possible.

The resumption of the Mining Exhibition and the Annual Dinner were the most notable events of the year, but it is to be regretted that owing to insufficient support, the latter resulted in a financial loss. This is not what it should be, and I hope that there will be no repetition of this lack of interest in connection with future social functions.

The Exhibition, from the educative point of view, was, as you are aware, a great success. We were indebted to our Honorary President, His Excellency Viscount Buxton, who graciously consented to open it. His Excellency's impending departure from South Africa is regretted by all sections of the community.

£ s. d.		£ s. d.	£ s. d.
	To Charges (including Postages, Bank		
(61 9 9	,, Charges, Insurance, etc.) ...	88 8 3	
69 17 5	,, Printing and Stationery ...	167 1 9	
16 14 0	,, Rent, Lighting and Telephone...	26 14 7	
596 0 0)	,, Salaries	778 10 9	
744 1 2			1060 15 4
	,, Loss on Annual Dinner		20 4 6
(20 3 3	,, Transactions: Cost of binding, etc.	36 3 9	
17 18 8)	*Less* Sales	6 13 9	
2 4 7			29 10 0
	,, Society's Journal—		
(690 10 3	Cost of Reporting, Printing, etc.	828 15 4	
655 12 3)	*less* Received for Subs. and Advts. after deducting commissions on Advts. and Collections ...	758 11 6	
34 18 0			70 3 10
	,, Grants and Prizes—		
	Prizes for Papers submitted ..	5 5 0	
(7 7 0	do. S.A. School of Mines ...	8 8 0	
25 0 0)	Grant to Seymour Mem. Library	25 0 0	
32 7 0			38 13 0
	,, Donation to Associated Scientific and Technical Societies of S. Africa		150 0 0
118 9 5	*Balance, being excess of Revenue over Expenditure for year.*		
£932 0 2			£1369 6 8

£ s. d.		£ s. d.	£ s. d.
	By Subscriptions—		
550 4 0	Members, current year ...	622 18 3	
98 14 0	do. arrears collected ...	124 19 0	
198 9 0	Associates, current year ...	224 4 0	
49 16 0	do. arrears collected ...	76 2 6	
1 1 0	Students	3 3 0	
898 4 0			1051 6 9
12 12 0	,, Entrance Fees		29 8 0
18 14 4	,, Interest on Fixed Deposits and Savings Bank Account ...		22 17 9
			1103 12 6
2 9 10	,, *Excursion Account.*		
	,, Balance, being excess of Expenditure over Revenue for year ...		265 14
£932 0 2			£1369 6 8

BALANCE SHEET, as at 31st May, 1920.

Dr.

1918-19 £ s. d.	LIABILITIES.	1919-20. £ s. d.	£ s. d.
(160 16 0	To Sundry Creditors		363 9 2
27 16 6	,, Subscriptions paid in advance ...		26 5 0
39 19 0)	,, Mining Exhibition Fund ...		39 19 0
	,, Research Endowment Fund ...		156 15 11
	,, Associated Scientific and Technical Societies of S. Africa ...		100 14 0
228 11 6			
	,, Revenue and Expenditure		
(562 6 9	Account—		
118 9 5)	Balance at 31st May, 1919 ...	680 16 2	
680 16 2			
	Deduct Excess of Expenditure over Revenue for year ending May 31st, 1920	265 14 2	
			415 2 0
£909 7 8			£1102 5 1

Cr.

1918-19. £ s. d.	ASSETS.	1919-20. £ s. d.	£ s. d.
	By Cash—		
249 2 7	Standard Bank of South Africa, Ltd., Johannesburg	119 7 3	
34 2 0	Standard Bank of South Africa, Ltd., London	130 15 3	
283 4 7	On Hand	17 14 7	
	Standard Bank of South Africa, Ltd., Savings Bank :	181 0 5	
405 13 4	On Fixed Deposit with Interest accrued	511 1 7	
			959 19 1
59 12 1	*Post Office Savings Bank.*		
115 17 8	,, Sundry Debtors		62 6 0
45 0 0	,, Office Furniture		45 0 0
	,, Stationery on Hand		35 0 0
£909 7 8			£1102 5 1

We have examined the above Balance Sheet and accompanying Revenue and Expenditure Account with the books and vouchers of the Society, and have obtained all the information and explanations we have required. In our opinion such Balance Sheet is properly drawn up so as to exhibit a true and correct view of the affairs of the Society, according to the best of our information and the explanations given to us, and as shewn by the Books of the Society.

Sgd. ALEX. AIKEN

(Signed) H. A. G. JEFFREYS,
Secretary.

The number of new Members and Associates who have been elected during the year shows a gratifying increase over recent years, but there still remain many who would benefit by association with the Society but who do not at present realise this. Resignations have unfortunately been heavy and, as stated in the Report, the Council has deemed it advisable to strike off the roll about 130 Members and Associates. Last year's Report stated the necessity for consideration of the position in view of the large number of Members and Associates whose subscriptions had fallen into arrears. The Council, however, will sympathetically consider any applications for reinstatement which may be received.

The losses by death have been large, and we have to record our regret and sympathy with the relatives who have been bereaved.

The necessity and utility of the Society has been shown by the large number of original contributions which have been received. It is hoped that the awards which it is proposed to offer under the Research Endowment Fund will result in original contributions of real merit being presented to the Society.

The Council regrets the delay in issuing Indexes for Volumes 18 and 19 of the *Journal*, which was due to the pressure of war work on the late Secretary in connection with the Red Cross Society. That applying to Volume 18 was issued with the May *Journal*, and Volume 19 is in the press and should be in your hands very shortly.

On the financial side it will be observed that the deficit on the year's working is chiefly due to increased salaries, which is in keeping with the spirit of the times and also to your donation from the accumulated funds towards the Joint Housing Scheme. I must acknowledge my sincere appreciation of the work of Mr. Thurlow, Honorary Treasurer, and his zeal in the interests of the Society. Mr. Rowland's resignation after his long secretarial connection with the Society was an unexpected shock. I desire to record the Council's appreciation, as well as my own, of the excellent manner in which Mr. H. A. G. Jeffreys, who was appointed to the vacancy, has carried out the duties.

The attendances at the Ordinary Meetings have been in no way commensurate with what we are entitled to expect. It should be realised that it is not right to leave the conduct of the Society to a few enthusiasts, and towards this undesirable position we are gradually approaching. Membership of the Society should be regarded as a privilege and an honour. It must be obvious to you to-night that we are not receiving the support we are entitled to receive. We have gentlemen elected to the Council who honour us by their non-attendance. We would like, and have reason to expect, their support at our meetings. In many instances, as you will see by the list of attendances at Council meetings, we have lacked the benefit of their presence. I consider this is a most undesirable state of affairs. It was suggested at the last Annual Meeting that the list of attendances should be issued with the ballot paper in order that members should know how to vote. I regret this was not done this year. I think the list of attendances at the ordinary meetings should be also issued; it might stimulate those members whose duty it is to attend. Another thing which I greatly deplore, in common with fellow Councillors, is the manner in which those who have passed the chair retire into an obscurity which we do not desire and do not appreciate, and I think that something should be done, by way of alteration of the Constitution, to get these gentlemen to come back into the fold and give us their support and advice, because I am sure their advice is valuable; they have passed the chair and have valuable knowledge regarding the working of the Society.

At the last Annual General Meeting it was announced that Peace had been signed and expressions of satisfaction at the pleasing prospect which appeared to be in view were made. Unfortunately our optimism has not been justified, and to-day we appear to be even further off a general settling down to pre-war conditions or something approaching those conditions than was then anticipated.

South Africa has, to a very great extent, been free from the troubles which have affected other countries, and it says much for those controlling affairs that where the spirit of unrest has appeared it has been speedily and satisfactorily dealt with. With good sense and a willingness to examine matters from all points of view there is no reason why this should not continue.

The last six years has seen an enormous advance in connection with the development of the potentialities of the country, and the figures obtained from the last industrial census reflect this expansion. There are now 5,918 factories within the Union employing 50,000 white and 84,000 semi-skilled, unskilled and native workers. The annual value of the manufactured goods was £61,000,000, and of the £34,000,000 of raw material, 53% was derived from South Africa.

During the last year many of the lower grade mines were only able to continue owing to the gold premium, but the gradually increasing working costs have in many cases nullified the effect of this premium, and to-day either a total cessation of operations or drastic retrenchment has been necessary. The serious position which would result, not only to the Transvaal, but to the whole of South Africa by the lack of employment of large numbers of workers is a matter of immediate concern to all of us. It is satisfactory to find that in one or two mines, where retrenchment has been deemed necessary, by co-operation and a spirit of mutual trust between employer and employee a monthly loss of some magnitude has been turned into a profit which, though of small dimensions, is evidence of what can be done by a realisation of the position.

In view of the marked advance in respect of new industries it is but natural to anticipate that these industries will soon be able to absorb those, who will require, as a result of the gradual closing down of the mines, to seek another market for their labour.

The transition period will doubtless be of a trying nature, but in carrying it out, it is not too much to ask that employers and employees will not impute ulterior motives to one another, and that a spirit of toleration will prevail in all discussions.

The potentialities of South Africa are attracting attention from outside, and the development of these latent resources will demand the skill and knowledge of those practising (among others) the professions embraced within our title. The Society's meetings afford a clearing house where new ideas and processes can be debated and criticised in a manner which would greatly help in a forward development of South Africa, and it is to be hoped that the opportunity afforded will be taken advantage of.

With these remarks, I have much pleasure in moving the adoption of the Report and Financial Statement.

Mr. J. Chilton *(Vice-President)*: I have much pleasure in seconding. In looking over the Annual Report and Financial Statement we get distinct proof of the healthy state of this Society. We are getting into our stride. We have started with the Exhibition and the Annual Dinner; we are getting back to where we were. Then again the papers which have been read before the Society have been remarkable for the ability shown by the writers. There is one thing which struck me about the Chemical, Metallurgical and Mining Society—it is this. We are about the only Society on the Reef which deals with what I might call the humanitarian or human side of the industry. When phthisis was the scourge of this country we dealt with that, and when the accident rate was appalling we dealt with that to some extent, and in the year that has just passed mercurial poisoning has been considered. We have not only kept up our reputation, but we have broken new ground in the closer housing scheme and in the Research Endowment Fund. So that I think, gentlemen, although it is matter for regret that our financial statement is not as good as it was, it is gratifying to know that we are exhibiting at least all the symptoms of a very healthy Society.

Carried unanimously.

The President: The Scrutineers' report.

Johannesburg,
26th June, 1920.

The Chairman,
Annual General Meeting,
Chemical, Metallurgical and Mining
Society of South Africa,
Johannesburg.

Dear Sir,

We have to report that we have received eighty eight closed envelopes containing ballot papers, and as a result of our scrutiny we find that the following gentlemen have been elected.

President.—Mr. James Chilton (unopposed).

Vice Presidents.—Mr. F. Wartenweiler, Mr. G. A. Watermeyer and Mr. F. W. Watson.

Hon. Treasurer.—Mr J. R. Thurlow (unopposed).

Members of Council.—

Mr. H. R. Adam
Mr. C. J. Gray.
Mr. C. H. Greathead
Mr. J. H. Johnson.
Dr. A. J. Orenstein.
Mr. E. Pam.
Mr. J. J. R. Smythe.
Mr. J. Watson.
Mr. E. M. Weston.
Mr. A. Whitby.
Mr. H. A. White.
Mr. J. A. Woodburn.

Yours faithfully,

(Signed) S. NEWTON, PERCY T. MORRISBY,
E. A. OSTERLOH, A. THOMAS.

The President: I congratulate you on the choice you have made of Office-bearers and Council for the ensuing year. In electing Mr. Chilton as your President you have elected a gentleman who has served a long and faithful apprenticeship on the Council and also as a Vice-President, and a gentleman who will carry out the duties of his office in a manner which will certainly meet with your approval. The Vice-Presidents represent each branch of our three sciences, and are also tried and trusty Councillors. With regard to the Council, we have to welcome back to the Council Mr. Pam, a former Vice-President, and Mr. John Watson, who for many years was on the Council, and you have also got an infusion of new blood, which I think is to its advantage.

Mr. J. Chilton *(Vice-President)*: I am very much obliged to you for your kindness in electing me as President for the coming year. I am still more obliged to you for the splendid support you are giving me by electing as Members of Council those gentlemen whose names appear on the blackboard. I notice I have got some of the veterans of the Society to steady me, and I also notice I have some new members to give enthusiasm and "punch." Gentlemen, I thank you for my election and for theirs.

Mr. F. W. Watson *(Member of Council)*: I desire to thank the members of this Society for the honour they have done me in electing me a Vice-President I appreciate the honour very highly, and I am sure I speak for the other Vice-Presidents when I say we shall do our best for the Society in the coming year, and will endeavour to uphold the position. Last year unfortunately I was unable to take much part, as I was away from the Transvaal. There was one remark which I noticed the President made in his Valedictory Address, if I may call it such, that was, with regard to the industrial wealth of the Transvaal, and I think we may hope for papers that will deal with things apart from mills, cyanide tanks and mine shafts. We hope to get some industrial papers in the future, and I am sure we may look forward to a future for this Society.

I beg to propose a very hearty vote of thanks to the Scrutineers for the way in which they have carried out their arduous duties.

Mr. C. J. Gray *(Member of Council)*: I have to thank you for honouring me by electing me a Member of Council, and in saying this I think I can also speak for the other Members of Council who have just been elected. It is not only an honour, but I suppose one should consider it a privilege to do his best for the Society. Personally, I shall endeavour to do my best and I think all the other Members of Council will endeavour to do their best also to attend the meetings and to do all they can to press forward the interests of the Society. At the same time, I would ask the members who are not on the Council to give us all the assistance they can in their power by attending the meetings of the Society and by contributing papers and notes to our proceedings on matters which may be of interest, and also that they will help as far as they can by inducing their friends to become members so that we can go forward and make the Society very much stronger than it is at present.

I second the vote of thanks to the Scrutineers.

Mr. S. Newton *(Member)*: On behalf of the Scrutineers, I would like to thank you all for the very kind remarks you have made in reference to the arduous duties we undertake and I may say look forward to every year.

The President: I desire to move a vote of thanks to our Honorary Auditors and our Honorary Legal Advisers for their assistance during the past year. The Honorary Auditors have a large amount of work falling to them every year, and I think it is but right that we should acknowledge our thanks to these Honorary Officials for their services.

PRESENTATION TO MR. F. ROWLAND, O.B.E.

One of the most pleasing duties which has devolved on me during my term of office is that which I am called upon to undertake to-night. It is a task which I nevertheless approach with feelings of regret, for it marks our formal farewell to our old friend and Secretary, Mr. Rowland.

The manner in which Mr. Rowland has served the Society during the long period of 23½ years he has been connected with it is well known to you. He became associated with it soon after its formation, and has seen the growth and development from a membership of something under 100 to the present day figures. It was with something akin to consternation that we heard the news of his resignation, but it was tempered by the knowledge that he was leaving to take up Secretarial duties with the Red Cross Society, which this Society was largely instrumental in founding and in connection with which we have always maintained a lively interest. As you may recall, Prof. Wilkinson was elected as your representative at the time of its formation and acted as its Chairman throughout the war, and your Council at that time granted permission to Mr. Rowland to act as its Hon. Secretary, which he continued to do until his recent appointment as Secretary.

Mr. Rowland is, therefore, not taking on anything new, but will be able to devote more time and attention to the very important work in connection with Red Cross propaganda.

Mr. Rowland's labours in connection with Red Cross, South Africa, during the war received recognition from the King, and the Order of an Officer of the British Empire was bestowed upon him. This evening it is our privilege to record in a tangible manner our appreciation of the services he has rendered to the Chemical, Metallurgical and Mining Society of South Africa.

I would ask you, Mr. Rowland, to accept this cheque, contributed by the Members and Associates of the Society, as a slight token of our appreciation of the devoted services you have rendered in your capacity of Secretary. At the same time, on their behalf, I wish you success and prosperity in the future.

Mr. F. Rowland *(late Secretary, C.M. & M. Society)*: Mr. President and gentlemen, I am not an extempore speaker, so I have written out a few notes, as I was informed that this presentation was to be made to me to-night. I am very grateful to you, Sir, for the kind words you have spoken and for this tangible mark of the appreciation of the members for the services I have rendered to the Society as its Secretary for so many years. When I look on you, Sir, and then look back, I begin to realise that I am growing old and also very grey and thin on top.

When I first took up the position of Secretary to this Society as an employee of the Rand Agency, Ltd., in 1896, I believe you, Sir, were still a boy at school, and I wonder whether you will, as so many Past-Presidents have done, simply leave the chair and then lose interest in the Society's work—I had written this before the President had written his remarks, as a matter of fact—but I do hope you won't, for it does so help things along if the old members continue to attend the meetings and buck things up.

It was on the 30th November, 1896, that I first attended a Council meeting and from that date until March, 1920, meeting, I do not think I missed more than four or five meetings altogether, either Council, Committee, or General Meetings, and then only through illness. That, I think, should be somewhat of a record

Mr. Feldtmann and Mr. Butters were the first two Presidents under whom I served, and it has been particularly gratifying to me to have received since I resigned, cordial and appreciative letters from both these gentlemen. I used to go and see Mr. Feldtmann frequently at his work near the Pass Office; he and Mr. Bobby Hall were together there, and they did a fair amount of work, I think, for the African Gold Recovery Company. I noticed the old place this morning, as I was down in that direction, had been turned into an Arab soft goods merchant's store. In those days, as the older members will remember, we had our meetings in the Council Chamber of the Chamber of Mines, and they will readily admit that the meetings then were considerably more vigorous than they are at the present time. It was before the days of the editorial blue pencil; members in those days gave and received pretty hard knocks, but they bore no malice afterwards, for they adjourned to the Club and had it out over again. Matters then were not so peaceful in the town or as restful as they are to-day, and, although Mr. Butters used to preside at the meetings in his regulation dress suit, he always used to produce his revolver from his hip pocket and lay it prominently before him on the table at the Chamber of Mines—I can see it now—a large silver-plated revolver. The journey to and from the Rand Central Ore Reduction Works in those days was not as pleasant or as comfortable as it is to-day. Of the members of the first Council I served under six have passed the chair, four have died, and three have disappeared. I do not know whether they are dead or otherwise, but I have not been able to trace them for some years. Mr. Littlejohn was on the Council most of the time—at least, all the time until this last year. I went to see him on two occasions when he was not expected to live; but I think we are all pleased to see that he is still splendidly fit, although he very rarely attends these meetings.

The membership when I took over the Secretarial duties was either 80 or 82, I forget which now, and the Society has progressed greatly since that date; but of late—during the last two or three years—interest has waned and membership has decreased. The reasons for this are hard to ascertain; possibly bioscope and other amusements in plenty, compared with the days of long ago, may account for a good deal, or else it is the removal of keen members from the Central Area to the Far East Rand—the wise men have gone out there. There may be another reason: the fact that problems on the Reef have become more or less standardised and require less discussion may also account for the decline in interest and attendance. Probably some of it may be due to shortcomings of my own; if that is the case, it is perhaps a good thing for the Society to have a change of Secretary; but still I have spent many happy years with you all, and it has been a very great wrench for me to sever my connection with the Society; after 23 years, it is difficult to say "Good-bye" and break old associations. I have endeavoured to give you of my best, and if I have failed at all it has not been for lack of trying. I can only say, in conclusion, how heartily I appreciate the manner in which I have always been treated by members, from President downwards, and to thank you once more and say "Good-bye."

Mr. W. E. Thorpe *(Member)*: I think it would be of very great assistance to the Society if the Constitution and Rules were altered to enable us to re-elect our Past-Presidents, and thus endeavour to increase their interest in the Society. I recently discussed the matter with one of them; he quite admitted that there were not quite as many members of the Society in his group as there were in the past. I think we might start afresh and see if we cannot revive their enthusiasm in the Society and its affairs. I would like to suggest that the Council considers an alteration of the Rules with that object.

Mr. W. S. V. Price *(Member)*: As this is my last attendance here as a member amongst you, I should like to say a word or two regarding the lack of interest shown by a man once he reached the chair and got as high as he could. I have seen the same thing in other societies; when they have got to the top of the tree they lose interest. They forget others want to get to the top of the tree, and that a helping hand is valuable. I came here some eleven years ago, first of all as an Associate and later as a Member, and everybody seemed to help everyone else. I must say I sincerely hope that you will persuade your Past-Presidents to come back and put the same amount of interest and push into it that they have done in the past.

Mr. W. E. Thorpe *(Member)*: There is one point which requires careful consideration. In a Society I am connected with I noticed recently, on looking through the list of Past-Presidents, that there were only about three names over a period of about 18 years, two of them having served some eight years each. We do not desire that sort of thing, but we do want to keep the interest of our Past-Presidents.

Mr. C. J. Gray *(Member of Council)*: I would like to say that, in my opinion, the proposition is a most excellent one. The little bit of work I have done during the past year and to which you have so kindly referred, has convinced me there must be a considerable amount of experience wasted in these gentlemen retiring in the way they do.

I think it would be better to refer the matter of making greater use of the Past-Presidents to the new Council for consideration as to whether there are any means by which it can be done.

The President: I may say this is no new point with me; I have felt it very strongly and, as several Council Members know, I have discussed it in the past. I do not think it is right, as one member has said, for a man once he gets to the top of the tree to lose all interest. We should do something to keep them within the fold and so get their advice and experience, which we admit is so extremely valuable.

BWANA M'KUBWA COPPER MINE, NORTHERN RHODESIA.

By E. M. Weston *(Member of Council).*

(Printed in Journal, September, 1919).

REPLY TO DISCUSSION.

Mr. E. M. Weston *(Member of Council)*: I thank Mr. Woodburn and Mr. Gibson for their contributions. Mr. Gibson will note that Dr Moleneux and other geologists agree that the dolomites of N.E. Rhodesia are of Archean age, and do not correspond with the dolomite of the Transvaal. The metallurgical tests were perfectly successful. Several thousand tons of mixed sulphide, carbonate and silicate ores we treated in the mill for an extraction of about 80%, which it is stated in a new mill could be increased to about 90%. Concentrates assayed about 26% copper, from ores carrying between 4 and 5%. This is, of course, a metallurgical triumph for the Minerals Separation Co. The mine is closed pending reconstruction to provide capital to operate on a large scale.

Members of this Society will be interested to learn that a local syndicate, under my technical direction, has been engaged developing a group of ore bodies about 30 miles west of Bwana M'Kuba. These give promise of developing into quite the largest mine in British South Africa, if not in Africa. As the deposits present several remarkable features I may at a future date make a description of them the basis of another paper.

AN UNUSUAL PROCESS IN THE TREATMENT OF GOLD ORE.

By B. L. Gardiner, B.Sc. *(Associate).*

(Printed in Journal, January, 1920.)

DISCUSSION.

Mr. J. Hayward Johnson *(Member of Council)*: Mr. Gardiner is to be congratulated on his paper which throws further light on the treatment of refractory ores. It is unfortunate that a complete analysis of the ore is not given, as, although he states the ore was completely oxidised, it is just possible that some of the iron contained therein was still in the ferrous state and that the contained moisture is probably in combination as thiosulphuric acid ($H_2S_2O_3$) which may be converted into thiosulphates during crushing in an alkaline water.

In connection with this paper a short resumé of the work in the reduction plant of the Machavie G.M. Co., Ltd. (situated in the Potchefstroom district), during period 1913-1918 may be of interest. The ore is typical of the "Black Reef" series and contains iron pyrite, marcasite, pyrrhotite, carbon, and contained moisture, which is possibly in combination as thiosulphuric acid.

The oxidised ore of the mine caused very little trouble as regards recovery of the gold, except for the presence of "rusty gold" (which was quite discernible even in the pan), this coating of oxide was readily removed in the tube mill circuit.

Once the oxidised zone was passed, recovery by cyaniding was very indifferent, 2·1% of the total extraction only being obtained, amalgamation accounted for 49%, and the gold recovered by chlorination, at Delmore (New Transvaal Chemical Co.), from the concentrates won, accounted for a further 19·3%, making a total recovery of 70·4%. By the original laboratory experiments it was hoped that an extraction of over 90% would be obtained, and a plant was constructed on the lines of these original laboratory tests, consisting of stamps, with plates, concentrating plant of Wiltley tables, Tube Mill with plates, Hendryx agitators and decantation vats (all sliming).

The first two charges treated in the cyanide plant gave a theoretical extraction of 83·5% (87% and 80%), but subsequently the extraction rapidly fell, until only 17% was obtainable, and by further experiment it was proved that only by crushing in fresh water and using a freshly prepared cyanide solution could the recovery of 87%, in the cyanide plant, be reached; this, of course, was considerably beyond economic limits.

The strength of solution used was 0·005% KCN, which was found the most economical and gave the best results. The gold content of the solution was highest immediately after the charge was transferred from the agitators to the decantation vats, re-precipitation commencing with the settlement of the charge, and samples taken during decantation showed a reduced value with remarkable rapidity. Further experiments were carried out on different lines, but without any marked success unless a freshly prepared solution was used.

The causes of bad extraction were evidently cumulative both in the mill water and cyanide solution as evidenced by the rapid decrease of recovery and by the fact that freshly prepared solutions gave good results. The carbon, pyrrhotite and marcasite present, no doubt, caused reprecipitation, but these were discharged on completion of treatment of each charge, so that it must be presumed that the thiosulphates present were accumulated, and either acted as a precipitant or rapidly consumed all available oxygen that was obtained during aeration in the Hendryx agitators, and therefore prevented any action on the other deleterious matters present.

On the advice of Mr. E. J. Way, Consulting Engineer, the cyanide plant was closed down in 1914, and he decided to experiment on roasting the ore.

The first experiment was a laboratory test by roasting in the muffle surface and subsequent cyaniding; this gave such excellent results that Mr. Way decided to carry out a larger test by having ten tons of the ore roasted on the reverberatory furnaces at the New Transvaal Chemical Works, Delmore, and it was found that with only a slight roast or heating an extraction of 90-94% was obtainable by amalgamation and cyaniding. Apparently due to de-hydration.

A further 104 tons was sent to Delmore, and, after heating, was returned to the mine, where 5 stamps were set apart to crush it (no tube milling was done) ordinary routine amalgamation and cyaniding was carried out and an actual extraction of 93·4% was obtained (recovery by amalgamation—54·7%, and by cyaniding 38·7).

In 1916, a hand-rabbled reverberatory furnace was erected on the mine, and 500 to 600 tons were heated, and the subsequent results of treatment by amalgamation and cyaniding gave an extraction of 94·36%. Recovery by amalgamation alone gave 68·4%, which was nearly equal to total recovery from all sources by the methods adopted in 1913. On the strength of the above experiments a mechanical roaster or heater of the tubular type was erected in 1917, and in October and November of that year 2,500 tons were treated, and fully proved the results of the preliminary experiments. The capacity of the furnace was twenty tons per hour with a consumption of 2 ton coal for 160 ton ore. One of the difficulties encountered was to obtain a suitable liner for the furnace, which would be both heat and wear resisting, which latter was very excessive, due to the passage of the ore through the heater. The cost of roasting or heating by this latter furnace did not exceed 2/- per ton. A total of 6,000 tons was treated by the above method, giving an actual extraction of just on 91%.

The coarse and fines were separated after heating, the former going to the stamps and the latter to the Tube Mill circuit, and the total pulp, all slime, to the Cyanide Plant.

I have to sincerely thank Mr. E. J. Way for allowing me to have access to, and contribute the above details and figures.

Mr. J. A. Woodburn (*Member*): I have been asked by the Secretary to contribute to the discussion on this most interesting paper, and as I realise that it is more a chemical than a mining problem, the following remarks are given merely in the hope that further information may be forthcoming from some of the chemical members, or in the reply by the author regarding this most novel method of treating an oxidised gold ore.

I have a specimen here which was taken from a very rich pocket in a gold quartz reef, and larger specimens of similar iron oxide on panning, gave a fine tail of coarse nuggety gold, and assays gave as high as 6 to 8 ozs. per ton.

One can understand if the gold is intimately associated with the hydrated oxide, the cyanide solutions could probably not percolate so as to dissolve the enclosed gold, although very fine grinding in most cases should accomplish this.

Evidently Mr. Gardner has found this does not take place with the Connemara ore, and partial roasting or baking gives better results. If a complete analysis both before and after baking were given, it would help one to judge better regarding his final conclusions, as so many gold mines have iron oxide or limonite in the oxidised zone, resulting from the decompositon of the pyrites generally found at depth, and this difficulty of extraction is rather exceptional, unless where other impurities have been found in the ore.

The author mentions the high consumption of lime in the original treatment, 6 to 8 lbs. per ton, and attributes the necessity for this to ferric sulphate. After baking the consumption of lime goes up to 10 and 12 lbs. per ton, showing that the baking process has evidently had a chemical, as well as mechanical, effect, and considerably increases the acidity of the ore. Ferric sulphate will decompose at a dull red heat, within the temperature range mentioned, producing ferric oxide and sulphuric anhydride, and this may account for the increased consumption of lime. The consumption of cyanide also is double in the slime treatment that of the sand, which is rather unusual, although the author partially accounts for this by the necessity of maintaining a certain strength of solution for precipitation.

In the table given on page 115 of the results of three months' actual treatment on baked ore, the theoretical extraction is calculated on the baked ore, when it should be on the original ore, in order to compare it with the original treatment. This difference is, however, not much, and it certainly shows a considerable improvement on the former treatment. The value of the heads, however, is higher during these three months, which tends to favour the figures in the baked extraction.

Taking the twelve months' figures as given on page 110, and dealing only with the cyanide treatment, the pulp consisted of 67% sand and 33% slime, and the head values were 6·07 dwts. and 5·47 dwts., and the residue values 2·3 and 1·9 dwts. respectively. Averaging these values according to tonnage gives—

Head value—5·87 dwts.
Residue—2·16 dwts.
Extraction—3·71 dwts., equal to 63·3%.

Had 13% of the gold been taken out by amalgamation before baking and the residue remained the same, viz., 1·23 dwts., then the extraction on the three months' baking treatment would have been 83·1%, compared with 63·3% on original treatment, which shows 20% better extraction by the baking process.

On page 111 the author states that without baking, rock from some parts of the mine yields better results than from other parts, the extraction in some months being as low as 63% and in others as high as 72%, a difference of 9%, and one naturally would like to know whether this was entirely due to the hydrated oxide of iron, or to some other cause not yet quite clear.

Mr. Gardner is to be congratulated on the results of his experiments, and in improving his extraction and thereby the profits of the mine, and no doubt further work will establish still better results.

THE IDENTIFICATION OF QUARTZ PARTICLES IN KONIMETER SAMPLES.

By Dr. A. W. Rogers, F.R.S. (Member).

(Printed in Journal, April, 1920.)

DISCUSSION.

Mr. T. L. Thorne *(Associate)*: Dr. Rogers deserves every credit in perfecting the Kotze konimeter method of estimating dust by taking advantage of the refractive indices of mineral particles.

He has disarmed the criticisms against the method as at present in use.

The chief criticisms hitherto levelled against the konimeter, claim the appearance of oil and water particles in the dust spot. To the uninitiated, all such particles looked like dust, though to the experienced eye each could be differentiated, *e.g.*, oil particles possess a bluish tinge.

Can figures be supplied of the refractive index of lubricating oils as used underground, and cylinder oil in surface compressors, and will these oils be soluble in the solvent film added to the dust spot? Realising that free silica particles under 3 microns diameter form the dangerous portion in mine dust, the Kotzé konimeter method gives in minimum time both a grading and petrographic analysis, and is now undoubtedly much handier, quicker and simpler than the sugar method, which gives only a total figure for dust, of sizes and mineral nature unknown.

NOTES ON ROUTINE ASSAYING AT THE GLOBE AND PHOENIX MINE, SOUTHERN RHODESIA.

By H. R. Edmands (Associate).

(Printed in Journal, April, 1920.)

DISCUSSION.

Mr. F. W. Watson *(Member of Council)*: The author's paper has brought to our notice some new ideas in assaying practice and will be useful, I am sure, to many assayers who have a comparatively small number of assays to handle daily. One remarkable point about the paper is that the author states that the ore contains on an average 2% of stibnite, and in his subsequent remarks, confines himself entirely to the physical aspect of the assaying problem and gives no details of the flux used; whether the stibnite presents any unusual difficulty and how this has been overcome. I am convinced that it would be of great interest to our members if the author would give us some idea of the flux used and how much oxidising or reducing agent was required. Also he might let us know what was the average size of the lead button obtained and whether the unusual impurity had any effect on it, or had a tendency to give low results unless special precautions were taken. The lack of these details makes the paper incomplete and consequently rather unconvincing.

The author's deductions on crushing of samples will give our assayers seriously to think. He has quoted Poisson's law, and gives some rather startling figures as to maximum and mean errors. I am afraid these theoretical figures as to possible errors would never come within the scope of practical assaying. Most of the assayers, who have been practising on the reef for a number of years, have had experience of the free milling ores which used to be found in the outcrop mines. These, especially in screen samples, gave a great deal of trouble and it was difficult to strike an average, but I am sure the discrepancies were never anywhere near those mentioned by the author in his theoretical deductions.

I must congratulate the author on his ingenious, simple and efficient type of sample crusher. The time element is the only point against its employment in assay offices, which have to handle a large number of samples every month. I doubt in that case, if the assayer could get through his work in anything like reasonable time, but for small propositions the mills seem to be efficient and economical.

The author's remarks regarding the treatment of reduction samples, containing dissolved gold, might well have been supported by figures to back up his contention that gold is redissolved on evaporating the pulp after treating with cuprous salt and sulphuric acid. Personally, I doubt if such solution takes place, and, if a number of samples have to be treated, I doubt if the air pressure filter would prove to be of much advantage over the ordinary evaporation method usually practised here with slime residue samples.

I do not think that the method of mixing of ore and flux by rolling on paper is much practised on the Rand; this mixing is usually effected by means of a mortar and pestle which is efficient and quick.

The author's furnace is novel in many ways. From the plan it will be seen that the top of the "bridge" is almost on a level with the roof of the reverberatory furnace. The abrupt lowering of the arch combined with the high bridge would, it seems to me, throw the heat back through the fire box and efficiency would be lost. Why should the floor be sloped? and why should the pots fall backwards rather than forwards? I doubt if the author has made out a good case in favour of a sloping floor as against a level floor, but that perhaps is a matter of personal opinion. Fifty-six pots seems an abnormally large charge for a furnace which is intended to handle only from 1,600 to 1,800 assays per month, and I question if it would compare economically with a smaller furnace.

The method of cupellation practised by the author is novel, and I cannot speak from experience as far as putting lead buttons in cold cupels is concerned. I am afraid if this method were carried out on the Rand considerable spitting of the lead would take place as the cupels are usually made of fresh material which consists mainly of magnesia. The author has been using reground old cupels, and it is wonderful to find the absorbent power of these so good. I wonder how the iron plates stand in the oxidising atmosphere and the temperature necessary for cupellation; a little information on this point would be illuminating.

All things considered, would not the author be better served by a smaller reverberatory furnace and a muffle than by the method described considering the small number of samples put through daily on an average?

With regard to the solution assays, I cannot see how the use of hydrochloric acid, for acidifying, should give low results. Surely on adding sulphuric acid to brine hydrochloric acid is generated and a sulphate formed, so I consider more data should be given than the bare statement that "sulphuric acid *must* be used," etc. With regard to the author's remarks about the zinc, lead acetate method, I would like to know if he has ever used zinc shavings instead of zinc dust, carried out the reduction at the boiling point and added the lead acetate, zinc and hydrochloric acid in their proper sequence. The zinc shavings should be made into a loose ball, weighing about 3 gm., the lead acetate (25 cc. saturated solution) added first, then the zinc and after about half an hour the acid. The solution should be boiling when each reagent is added, and, if this is carried out, a compact lead sponge is obtained, without filtering, which can be dried and cupelled direct, and the results are very accurate.

The author has certainly given room for discussion in his paper, and has given us several new ideas. Whether we agree with his conclusions or not, I am sure we will all agree that he deserves our thanks for putting his views before us, and we hope that he will amplify his paper in his reply.

THE GOLD PREMIUM.

By S. Evans (Associate).

(Printed in Journal, May, 1920).

DISCUSSION.

Prof. R. Leslie (University of Cape Town), (*Contributed*): I am in entire agreement with the author in his analysis of the causes of the rise in prices. Money is simply purchasing power whether the money is gold or paper. If this purchasing power is increased while the supply of goods remains the same its only effect is to increase the average price of all goods. If the supply of goods falls off then less money is required to enable business to be carried on at the old level of prices. Some years ago Prof. Irving Fisher proposed a method by which steadiness of the general level of prices could be obtained. His proposals, which were approved by statesmen such as President Wilson and by economists such as Prof. Marshall, were intended to operate by reducing the supply of money when prices rose and to increase it when prices fell, thus continually applying a brake to movement in either direction. Instead of this, in recent years when prices rose owing to shortage in supply or some other cause, we have not been satisfied to accept the rise which would have taken place if the quantity of money had remained the same but have even been speeding up the rise by increasing the quantity of money. Though a statistician would hesitate to assign definite proportions of the rise in prices to the falling off in supply of goods, to the increase in the supply of money, and to such minor factors as the alteration in the number of times that money and goods change hands, economists are agreed that the increase in the quantity of money has been the chief cause. They are agreed, too, that any increase in the quantity of money will increase prices. In South Africa the proportionate increase in prices has lagged behind the increase elsewhere; partly because the increase in money was in part balanced by an increase in production, partly because the expense to the banks of replacing gold under our present system has been a fairly effective check on the increase in the quantity of money here. If this check is removed by the issue of an inconvertible currency or the adoption of methods which will effectively stop the leakage of gold, there will be a very strong tendency for the quantity of money to increase and for our prices to rise in the same proportion as European prices. There are many people who declare they wish to see a fall in prices, but yet fear any remedy for high prices which may result in money leaving the country. They point to the great drain of gold from America after the removal of the embargo. Yet until this gold leaves America any considerable fall in prices is impossible.

When money falls in value relatively to commodities there is said to be a general depreciation of money, when it falls relatively to the money of other countries or to gold, *i.e.*, when a premium on gold arises, there is said to be a specific depreciation. Though the same causes have brought about the general and the specific depreciation of money, *i.e.*, the rise in prices and the premium on gold, the one is not an exact measure of the other. Specific depreciation, the premium on gold, may and probably will disappear sooner than the general depreciation. If prices in all countries rose equally no premium on gold need arise. The premium on gold arises when more money is manufactured in one country than in another. The first country has more money with which to buy the products of the second. Moreover, the rise in prices within it makes it a good country to sell to and a bad country to buy from. The balance of trade turns against it, exchange becomes unfavourable, and equilibrium is only obtained when the rise in exchange or in the premium on gold takes away the advantage of the higher level of prices. Thus there is a constant tendency for exchange to turn against a country not to the amount which balances the general depreciation, but to such an amount as will balance the excess of general depreciation over general depreciation in other countries. Some time ago the specific depreciation of the mark was out of all proportion to the rise in prices in Germany. The forces of which I speak are now improving the German exchange and also bringing about a rise in German prices. This will go on until equilibrium is obtained at a point where the depreciation of the mark just balances the excessive rise of prices in Germany.

In South Africa the fact that prices have not risen by such a large percentage as in Europe has already given us an exchange on London which is 7½% in our favour, *i.e.*, the specific depreciation of our currency is only about 15% as against 23% in the case of English currency. There is at present a movement on foot to depreciate our currency to the value of British currency so that exchange on London may be at par. The effect can only be to cause our prices to rise in the same proportion as English prices. In fact one finds many who wish to bring about this specific depreciation of our currency supporting profiteering and other bills by which it is hoped to bring prices down. The attempt must end in failure. If by any means we keep prices here from rising as much as in England, then exchange must turn in our favour. If the value of our money falls less than English money does relatively to commodities, then it must also fall less relatively to commodities.

Dr. W. A. Caldecott *(Past-President)*: The author's able paper, based on a lifetime of financial and banking experience, is enriched by a wealth of quotations from authorities upon the evils of currency inflation. Up to now, we have had newspaper controversy, conducted at a thousand mile range, between eminent exponents of specific interests, as well as the published conclusions resulting from the discussions of Government Commissions sitting in camera. Various ingenious proposals have also been published by writers in the daily press, but it is only now that, through the medium of this Society, an opportunity has been afforded to those primarily concerned to discuss and elucidate this vital question.

The author's main point that high prices with all their consequent evils are largely due to an increased volume of currency and bank credits seems obvious, as following from the operation of the ordinary laws of supply and demand, in relation to an increased amount of currency and decreased supply of commodities in the world's markets. To the author's numerous citations on the evils of an inflated and inconvertible paper currency elsewhere oversea, there might be added striking illustrations from the monetary history of South Africa, as detailed in Mr. Barker's paper on the subject, which was read before the South African Institute of Bankers on 6th November, 1906.

The main portion of the author's paper is devoted to proving the main principle, so that some observations from a layman's standpoint in regard to the question as it affects South African gold producers may not be out of place In the first place it is clear that gold viewed as a commodity will fetch the highest price when the widest market is available, and when there are no restrictions on its world-wide sale. During the war these conditions were necessarily absent with the ready acquiescence of gold producers, but even now pre-war freedom is by no means existent. Import of gold into India for instance is prohibited except by its Government, which was recently buying our gold in London at 110/- per fine oz., and retailing it in India at 150/- per oz. at the rate of 250,000 oz. monthly. The Indian Government thereby made a profit of some £500,000 monthly, whilst at the same time the cost in South Africa of imports from India of grain bags, wool packs and rice was greatly increased owing to the artificially induced unfavourable rate of exchange. In this way South African gold did not obtain the highest premium existing, and similarly Australian gold has been sold in China at 135/- per fine oz., whereas the highest price obtained by South African gold in London was 127/6 per fine oz. In Australia the combination of gold producers, the Commonwealth Bank and the Government, thus enabled better terms to be obtained than we have secured, just as early in 1919 Australian gold was sold at a premium of 20% whilst ours was still being sold at mint par.

Viewing gold as a commodity, which constitutes the basic stock-in-trade of banks, it follows that the banking and mining interests are necessarily divergent. The gold mines desire the highest price in currency for their product over a world-wide and free market, just as if they produced copper or tin. The banks on the other hand desire to restrict freedom of sale to facilitate diverting as much of the precious metal at as low a price as possible into their own coffers to serve as a basis for their issues of paper. Freedom to possess, hoard, use in the arts, or export gold anywhere enhances its value, or in other words, reduces the gold price of commodities, whereas from the banking standpoint all these measures tend to render it more difficult and costly for them to acquire the world's current gold output, to which South Africa contributes one half. Whilst issues of notes only partly secured by gold is a source of much profit to the banks, from a mining standpoint this practice reduces the demand for and lowers the price of their product, so that as has been said "Paper is the enemy of Gold."

The deflation of currency advocated by the author is obviously best secured by a gold standard, which has the prime merit of limiting the volume of currency. Under normal conditions this would imply the legal right to obtain gold in payment on demand, but all monetary history shows that a gold currency cannot be maintained in any country where its bullion value elsewhere is greater than its face value in the country issuing it. The consequent drainage of South Africa of gold coin with free export would probably lead to a renewal of the predatory proposals for the Government to commandeer the mines' gold at mint par to supply the loss, and under such conditions the proposal to issue treasury certificates fully backed by gold as a temporary measure would appear reasonable. Proposals, however, to "economise gold" by the issue of notes only partly secured by a metallic backing are counter to the gold mining interest, on which this community and all South Africa so largely depend to pay for its imports. Such a measure merely constitutes a form of currency inflation whose evils the author has so fully dealt with. Inconvertible paper issues unbacked by gold possess great attractions to the issuers (who as bankers usually advise Governments on currency questions), as practically constituting a free loan from the community, though they lessen the value of all prior currency and are at the cost of those with fixed incomes or with past earnings. Unfortunately, rising prices due to currency inflation are attractive to others than bankers, since the trading community profit thereby, and also the Government, whose revenue rises. During the war inflation of currency and bank credits afforded banks unprecedented profits, whereas gold mining all the world over suffered so severely that the output has decreased by about 30%, and is obviously liable to much further decline.

Under present conditions our premium on gold in terms of English paper currency is practically identical with the premium on gold-standard American currency in English currency, so that when parity of exchange is resumed between London and New York it follows that our premium will disappear, and with present working costs half the mines on the Rand will shut down. The importance of a free world-wide market for our gold is hence obvious, and also of a distributing system enabling anyone in however humble a position anywhere to acquire the portable form of wealth which we produce, even in the form of the single quarter-ounce ingot termed a sovereign, whose weight and fineness are guaranteed by the impress of the die. World-wide unrest, fear of a capital levy, and other apprehensions for the future are all causing a universal demand for metallic gold which, if it could become effective and unhampered by embargoes and other governmental action, would afford a better market and price than now exists. To illustrate how readily our gold could be absorbed, it may be pointed out that if each inhabitant of India hoarded only one rupee's worth of gold yearly it would take the whole of the South African annual yield to satisfy the demand of this one country alone. The main function of the South African refinery and mint will be to convert our present unrefined bullion into refined bars, coins, or other marketable forms desired by any purchasers in Asia, South America or any other market, which a selling organisation on behalf of the mines could supply in the same manner as oil or any other commodity is furnished to those who will pay the price.

Mr. H. A. White *(Member of Council)*: Before I read the contribution which I have prepared on this subject—it is not very long—I should like to call attention to what I think is a blunder on the part of Prof. Leslie, who has endorsed the heresy of Mr. Strakosch, that the principal active source of the gold premium is through the Foreign exchanges. Prof. Leslie seems, as far as I have heard, to embody this principle in what has just been read. That view was completely exploded by Ricardo more than 100 years ago. You will notice in Dr. Caldecott's contribution the export of gold to India is stated to be under an embargo; as you will see from the Press that has now been removed and the papers express the opinion that the result will be of advantage to this country. Now, it cannot possibly be of any real advantage to this country. If gold is sold for £7 an ounce in India, what does this £7 mean? Seven sovereigns in gold coin? Certainly not. It means Indian currency; proving that Indian currency is much more inflated than British currency. As you will have noticed, there has recently been an Economy League instituted in this country and the traders have gone out of their way to show it cannot possibly be successful in reducing prices; I think, on the other hand, economists feel they have all the chances of success in front of them; but I would like to point out to them one other method much more likely to be successful than any they have attempted; it is this, whenever they go to the bank and exchange cheques they should demand gold, and, whenever they require change in the shops they should express a strong preference for gold instead of paper. The necessary provision of gold to meet that demand will have a much better effect on prices than any little economies they can possibly perform.

Mr. H. A. White *(Member of Council):* It is fortunate for students of economics that the principles to be employed in dealing with problems of currency and exchange were laid down by Ricardo at a time when very similar financial problems were agitating Europe to those the world has now to face. When peace follows a war of exhaustion postponed difficulties of finance have always to be dealt with, and these will be aggravated until statesmen realise that the opportunist method of forced loans by issue of paper money will always meet with the severe punishment following broken economic law.

It is pleasant to note that the author has based his examination of the gold premium upon a loyal acceptance of economic law, and thus on a plane where finance is allied with pure science. His review of the problem is a very wide one and thus gives the proper perspective for a study of the more local aspects of the question in which we are vitally interested. The debt which our Society owes to the author for answering their request for a paper on this subject, in so able and thorough manner, can possibly be best acknowledged by an endeavour to apply his facts and methods to the difficulties of the present situation.

The author has made it quite clear that the misdeeds of European statesmen in multiplying inconvertible paper provide no excuse for high prices in South Africa, and the example quoted from California makes it quite certain that our difficulties arise from our own blunders chiefly. We cannot even blame our own Government for anything beyond (1) neglect of any attempt at regulation of bank note issues, such as increasing the interest tax thereon on a sliding scale, corresponding with proportion between notes issued and reserves of gold coin; and (2) the placing an embargo upon export of gold coin, which is exactly robbery of the holders thereof coupled with a bonus to unscrupulous law breakers.

It is very much to be regretted that the Washington Labour Conference, in arranging the agenda for next year's meeting, made no reference to requesting the governments, included in the League of Nations, to make speedy preparations for resumption of cash payments by withdrawal and cancellation of superfluous paper currency, which in effect means giving priority in payment to their debts of honour. Labour should have seized the opportunity of making its voice heard on a question in which it is most vitally interested. If the great "salariat" had been adequately represented, as it should have been, this serious omission would have been avoided.

Available statistics are insufficient for an estimate of the total inflation of currency in South Africa, and only a rough suggestion of the facts can be based upon the following considerations. General merchandise handled by railways may be taken as an indication of extent of business transactions, and thus of the demand side of the currency equation. Sir Thomas Watt in his recent railway budget speech gives the figure 6,834,000 tons of general merchandise carried on the railways for 1919, and the corresponding figure for 1914 from the South African Year Book is 5,392,000 tons, and the ratio is therefore 1·267/1.

The author's figures for the supply of currency, assuming the banks' proportion has not changed, is 16205/9063, or 1·788 for the same years and inclusive of notes and gold. The result is that while business has increased 27% currency has increased 79%, and if velocity of circulation may be assumed as unchanged the inflation of currency, 1·788, 1·267 or 1·411 must amount to over 40%.

It is agreed that a reasonable estimate of increased cost of living for 1919 would be about 40%. This viewed in another manner is only another name for the decreased purchasing power of the £1 unit of currency and the conclusion is unavoidable that the higher cost of living is due neither to profiteering, to the war, or to anything else but the inflation of our own currency. Now, this inflation of currency is not entirely due to excessive issue of paper, which to some extent merely replaces gold coin formerly and wisely used, but the depreciation in gold itself must be considered in this connection. This is a point upon which the author has only lightly touched, and other contributors to the discussion, while not refusing to admit the fact, scarcely realise that to this alone is due the necessity for closing down so many mines which have now passed below the pay limit. This very important point will repay the closest study in the interests of our main industry.

From the table in Appendix 6 we ascertain that the gold reserves as far as known for 1914 amounted to £1,000,000,000, and for 1919 to £1,407,000,000; if production of commodities were the same and velocity unaltered this would show a depreciation in gold of 1001/1407 = 0·711, or, roughly, 30%, or allowing for increased requirements of 2% per annum it would leave a nett excess of 20%, and this would measure the depreciation of value of the gold sovereign measured in commodities generally.

The fact that gold itself has depreciated in spite of the so-called premium (merely a euphemistic expression for the effect of depreciated currency) is illustrated by the diagram given by Mr. Henry Strakosch in his brochure. "The S.A. Currency and Exchange Problem," where the price indexes for nearly all countries in the civilised world show substantial increases independently of whether they were engaged in war or neutral, whether their currencies were depreciated by excess paper or based on gold, or whether their trade balances were "favourable" or not. Of course these particular indexes are based on food prices where scarcity causes a disproportionate increase in price and would require an unknown amount of discounting to compensate for this effect and for results of trade dislocation. The table in Appendix 1, given by the author, shows that the cost price of our gold increased about 24% between 1914 and 1919, and this supports the figure of 20% arrived at above if allowance is made for certain taxation and other special charges.

In the long run the value of gold must depend upon the cost of production in the most unfavourably situated mine that can be kept working without loss, and the figures in Table 1 used in this way for 1914 and 1919 show

$$\frac{\pounds 3\text{ 1s. 11d.}\quad 779}{\pounds 4\text{ 0s. 3d.}\quad 963}\quad 80{\cdot}9\%$$

and again bring us to acknowledge a 20% depreciation in gold values. This latter argument is perhaps unduly compressed, but the fact is obvious that superfluous gold mines are shut down by rise of costs caused by the excess supply, over demand at former level.

A contributory to this depreciation, mainly caused by excess production, is possibly a falling off in industrial consumption and to replacement of metallic circulation by paper issues even where these are convertible as in America. Appendix 6 shows an increase of 406 millions of gold reserves in 1½ years, or about 85% of output leaving 17 millions per annum for industrial consumption against 22 millions estimated for 1910 by the United States mint, without any allowance for the Oriental absorption which no doubt was much reduced during the period.

The replacement of about 100 millions of gold coinage in England by treasury notes and similar effects in many Continental countries must have a depressing effect on gold mining as long as it continues, and our obvious interests in this country demand a campaign of enlightenment to the world at large upon the enormous economic importance of a stable gold currency and of endeavour to increase the industrial consumption in every possible way.

The only historic guide of importance on the question of how long the gold premium (in English currency) will last is quoted in the author's table 3, which shows that between 1815 and 1816 it was possible for the premium to nearly vanish, so that it is clearly possible if suitable measures are taken by the British Government, such as the withdrawal and cancellation of about 20 millions of treasury notes per month for the premium to vanish before the end of next year, and any considerable increase of production would assist to reduce this period. This would in reality only mean the preferential payment of the debt of honour in which the issue of superfluous paper has involved the Government and would of course make no real and lasting difference to the mines here. It would, however, remove the present unscientific way of presenting mine accounts where receipts are expressed in gold units and the expenses in currency units in some cases, and in most cases in units of the same name but different values on the two sides of the statements.

It should be emphasised that the mines can only actually realise a premium based upon our local currency inflation, which merely means an alteration in the unit of accounts, and this would neither prolong the life or hasten the end of any mine whose profitable life must depend upon the value of gold as expressed in general commodities and not on its relation to currency which can only temporarily confuse the issue. The real cause of the closing down of the mines which we are beginning to face is the 20% depreciation in the value of gold for which the 40% inflation of currency was a temporary palliation comparable with borrowing in order to pay debts.

Our permanent interests can not be secured by any attempt to prohibit export of gold in coin or any other way or to reduce the uses of gold by substituting the use of paper, whatever may be printed upon it. You will observe that however foolish some wool farmers may have shown themselves recently they were none of them unwise enough to propose the prohibition of the export of wool in any form as a remedy for low prices in this country.

The corollary to the proposition that excess gold was being produced is that at least one other thing is not being produced fast enough, and possibly coal is the one thing most behind the times. This suggests that in coal mining and in preparation for its carriage and export would be found the solution of the problem of unemployment caused by the closing down of gold mines if well organised effort were made by all concerned.

Mr. H. A. White *(Member of Council)*: Before the meeting is allowed to close, I think it would be only correct if I were to voice your strong approval of the extraordinarily efficient way in which our present President has carried out his duties during his term of office; the zeal and ability which he has shown has done very much to lift this Society out of the rut of depression into which it had fallen.

The President: I thank you for the manner in which you have received the remarks by Mr. White. I can assure you I appreciate most sincerely what he has said with regard to my association with the Society. I may say I have had an extremely strenuous year, but I have done what I could to push the Society on for I think that the Society is a real, live force. I remember when I was a junior member of the Society seeing this hall crowded to the doors, and I want to see those days again. In the transition period from the mining industry to the industrial side there is a great opportunity for the Society, which can meet the demand in connection with industrial work as it met to a very great extent the demand from the gold industry; it has a great reputation behind it, and I see no reason why it should not maintain that reputation in connection with the industries which are developing and which are bound to develop in the future in South Africa. I thank you again, gentlemen. I am sure that those who supported me during my year of office will as heartily support my successor; I may say a President needs a lot of support, and I hope and feel sure that Mr. Chilton will get it.

The meeting terminated at 10.30 p.m.

Book Reviews.

ORE MINING METHODS.

By Prof. W. R. Crane, Ph.D.

Second edition—New York: John Wiley & Sons. London: Chapman & Hall. 277 pages, 6 by 9. 35 full-page plates and 48 illustrations in text.

The book contains descriptions, which are generally clear and excellently illustrated, of typical methods of mining. The circumstances under which those methods are used and their advantages and disadvantages are described and discussed. A bibliography is given at the end of each chapter, which it is noticed often includes papers read before this Society.

Unfortunately the author's personal inspection having been, as he states, confined to the mines of the United States the descriptions of and reference to South African mining are not quite satisfactory.

The description of Kimberley mining is out of date, no reference being made to the important improvement effected by adoption of inclined chambers. Rand experience would cause the author to revise his statements:—p. 22, "No expense is attendant on their (pillar's) use." p. 23, "They (cribs or pigstyes) cannot be used to advantage except in horizontal or slightly inclined deposits or wide veins," and p. 46, "The limiting distances for efficient work in moving loaded cars by hand are between 600 and 800 ft." Knowledge of recent Rand practice in developing deep levels by vertical shafts and separate underground inclines or verticals, and of the troubles experienced with the bends in compound or "turned-vertical" shafts would suggest modification or qualification of the opinions expressed. "Pp. 23-38, as to the conditions under which vertical and inclined shafts respectively are suitable, and of the opinion on p. 38 that "turned-vertical" shafts possess practically all of the advantages of inclined and vertical shafts, and on the other hand have few of the disadvantages of either considered separately." The book hardly touches upon the difficulties encountered at great depths owing to both superincumbent pressure and internal rock stresses, but as I have heard said, we are working on the Rand ahead of the text books.

The book should be valuable to the student, and to the practical man who wishes to devise the most satisfactory method of working a difficult deposit or to improve on the method in use.—(C. J. G.)

Notices and Abstracts of Articles and Papers.

CHEMISTRY

Extraction of Bromine and Potash in Tunisia.—"On the outbreak of war France sought to purchase bromine and bromides from America, but owing to high prices and insufficient supplies the attempt was unsuccessful. Increasing scarcity rendered the position serious, and in April, 1915, when bromine compounds were required for use as lethal gases, the salt marshes or lagoons of Tunisia were investigated, and found to be capable of furnishing a plentiful supply of bromide. In December, 1915, Sebkha el Melah, near Zarzis and one kilom. from the sea, was selected as a suitable site for operations. At this place there occurs a saline deposit covering a thick compact mass of black clay alternating with layers of gypsum mixed with sea salt, the whole being impregnated with a concentrated solution of sp. gr 1·238 (at 21° C.), which contains, *inter alia*, 13 gm. per litre of potassium chloride and 2·24 gm. per litre of magnesium bromide. The situation rendered transport difficult, but wells were sunk, a railway laid, and works erected at El Hanèche, with six Kubierschky apparatus and other necessary equipment. This locality was able to supply all the bromine required in 1916 and 1917. Each apparatus treats 100 cu. m. of liquid per day and produces 160 kilo. of bromine from a solution of 27·3° Bé, 350–370 kilo. from a solution of 31–32° Bé, and 520 kilo. from liquor of 34° Bé. Very much lower yields are obtained from sea-water, of which only 80 cu. m. can be treated daily. From May 1 to December 25, 1916, the El Hanèche works produced 1050 metric tons of bromine. The chlorine necessary for the process is supplied from France. During the latter half of 1918, a new bromine works was started at Aïn es Serab, and the two works together are expected to produce 80 tons of bromine per month for the first few months of 1919, and afterwards, by treating liquor of higher concentration, 120—130 tons per month.

At Mégrine a process, proposed by Professor Urbain, was adopted of precipitating potassium, free from sodium, as fluosilicate, by the action of fluosilicic acid on the mother liquor from bromine distillation. The fluosilicate is treated with milk of lime, the resulting solution of caustic potash concentrated in a Kestner evaporator and then over an open fire. The fluosilicic acid was at first specially prepared at Mégrine, but afterwards obtained as a by-product from the superphosphate works at El Afrane. High working costs and foreign competition stopped the manufacture after several tons of potash had been produced.

At the salt marshes of Sfax, the Lambert Rivière Co has installed a plant for treating the mother liquors on the Merle system. The natural salts found there include a substance called sebkaïnite which contains:—KCl 19·5%, NaCl 10·0%, $MgCl_2$ 27·2%, $MgSO_4$ 9·3%, water and insoluble matter 34·0%. After removal of the potassium chloride, bromide is extracted from the mother liquor. The recovery of potassium chloride from this mineral was started in March, 1917, and, up to the end of January, 1919, the following quantities (metric tons) were produced at El Hanèche:—70% KCl, 700; 35–40% KCl, 1400; 90—95% KCl, 50. In 1918 the Tunisian government decided to erect a works capable of producing 4500 tons of pure potash salts near a marsh of 200 hectares area at Aïn es Serab. Electric power stations have been erected, but owing to delay in delivery of goods, the installation is not yet in operation, but is expected to be ready this spring. The plant will deal with at least 50.000 tons of sebkaïnite.

It is anticipated that, eventually, the Tunisian deposits will rival those of America and Germany."—(*Bull. Soc. d'Encourag.*, Jan.—Feb., 1919.) *Journ. Soc. Chem. Ind.*, April 30, 1919, p. 146B. (J. A. W.)

Abstract of Patent Applications.

100.19. H. E. Morgan and J. J. Lategan. An improvement in locking devices for stamp battery fingers and the like. 12.2.19.

This patent application is for a pawl or finger which will prevent the accidental disengagement of the battery finger from the tappet of a stamp mill.

391.19. T. E. Bond. Improvements in rollers for supporting ropes and the like. 21.5.19.

This application refers to improvements in rollers for supporting ropes and the like, comprising a drum or barrel portion, two circular end plates or discs between which the barrel portion is arranged and retained, a central tube which at its ends is screwed into the end plates, said ends being then expanded in or rivetted over the outer sides of the end plates, a perforated hollow or tubular spindle upon which the central tube rotates, plugs which close the ends of said spindle, a bracket which non-rotatably supports the spindle, a split pin or its equivalent which passes through the brackets and the spindle and the plug in end thereof, and serves to attach the non-rotatable spindle to the bracket, the plug in the other end of the spindle having a hole to allow of the introducing of lubricant into said spindle, and a screw for closing said hole, substantially as described and shown.

1064.19 J. F. Wells. Improvements in connection with a process and apparatus for carbonising wood and other carbonaceous material. 20.2.19.

This specification describes the carbonisation of wood, peat, or waste vegetable matter in a special form of gas producer, whereby the material treated is carbonized by the heat evolved from the combustion of a portion of its volatile constituents and the charge is withdrawn when the last portion of the volatile constituent is being consumed, the bottom of the producer being provided with a hinged grate and a rotating paddle to withdraw the resulting charcoal into a reservoir containing water.

430.19. J. R. Thurlow. Improvements relating to dressing amalgamating plates. 4.6.19.

66.20. J. R. Thurlow. Improvements in portable rotary cutting machines. 22.1.20.

These applications relate to a machine designed to remove amalgam from amalgamating plates, and consists, briefly, of a motor mounted on a frame, which in turn is mounted by springs upon a carriage provided with wheels. The severing members are in the nature of rotary wire brushes, and are driven from the motor by suitable gearing. Curved shields are placed round the rotary severing members to direct the loosened amalgam into collecting boxes.

In operation the machine is placed on the plate, the motor started, and the brushes lowered into the desired position by means of an adjustment screw spindle and a turnbuckle. The machine is then traversed over the plate by means of the handle supplied, until the desired amount of amalgam has been removed.

497.19. T. J. Armstrong. Improvements in cement or concrete pipe or the like. 26.6.19.

This application relates to a pipe or the like of the nature indicated, consisting of an internal section, part or lining, of cement or concrete, and an external section part or covering of cement or concrete, and a steel or other suitable metal cylinder placed intermediate to said internal section, part or lining, and said external section, part or covering substantially as described.

A pipe tube or the like, as claimed in the preceding claim, in which the internal section, part or lining and the external part, secton or covering are either or both reinforced, substantially as described.

498.19. T. J. Armstrong. Improvements in joints for cement or concrete pipes and the like. 26.6.19.

This application is for a joint or means for connecting together the ends of cement or concrete pipes, tubes and the like, characterised by a construction in which the interior of the faucet or socket is made concave by inwardly curved or oppositely tapered or inclined surfaces.

A joint or means for connecting together the ends of cement or concrete pipes, tubes and the like, according to the preceding claim, in which the spigot end of the pipe is serrated or grooved externally.

A joint or means for connecting together the ends of cement or concrete pipes, tubes and the like, according to either of the preceding claims, in which the faucet or socket is constructed with a recess (as 15) at the bottom to receive the spigot end of the adjoining pipe or the like, with or without a packing ring (as 19) between the spigot and the bottom of the faucet or socket.

586.19. B. Junguera. Improvements in the manufacture of concentrated solutions. 28.7.19.

This application relates to the separation of soluble substances from rock, ore, or other material, the apparatus used being composed of a pair of cylindrical rotary drums, one within the other, the walls of the inner drum being formed of perforated material. By means of an axial cone, the liquid used as the solvent is passed into the radial space between the drums, and drawn inwards through the perforated material composing the inner drum, and thence through the bed of material deposited by centrifugal force.

611.19. L. Linden. Separating the respective lighter and heavier matters from a flowing liquid. 6.8.19.

This application is for an oil separator of the elaborated Spitzkasten type, for the purpose of separating lighter from heavier liquids by providing opportunities, including raising temperature, for the exercise of the specific gravity functions of the various constituents of an oleaginous flowing liquid. The apparatus is a combination of well-known principles of separation.

708.19. J. de R. Kielland. Safety nut. 2.9.19.

The claim for this application is in a safety nut a deep sloping helical thread rib which is adapted to yield axially with its inner edge, thereby pressing the nut thread against the screw when the nut is pressed against a stationary surface.

896.19. Merz and McLellan. Improvements in or relating to means for feeding furnaces for boilers and other purposes with solid fuel. 7.11.19.

This specification describes a method for drying and pre-heating solid fuel for boiler furnaces in a chamber outside the combustion space of the furnace grate, by carrying a layer of the fuel on a perforated conveyor travelling through the preheating chamber, and directing waste fuel or other low-temperature gases through the layer of fuel—by passing the flue gases through the layer of fuel it is also claimed that a large portion of any dust contained in those gases is filtered out before the waste gases are discharged into the atmosphere.

991.19. F. Seymour. Improvements in pulverizers and process of fine grinding. 3.12.19.

This application describes a pulverizer of the rotary hammer type, consisting of a plurality of chambers and hammer discs separated by diaphragm and with fan attachment, designed for the pulverization and classification of fuel in an air-current, which also conveys the fuel intimately associated with the air to the point of combustion.

1018.19. T. H. Bradbury. Improvements in the method of sharpening rock drills and the means therefor. 8.12.19.

This application refers to rotary drill sharpening machines of the kind described in the complete specification of Patent No. 647 of 1917, which consist of one or more rapidly rotating discs on the periphery of which teeth are formed.

The applicant proposes to provide a means for rotating the toothed disc at the necessary high rotational speed by mounting an impulse turbine wheel on the same shaft as the disc.

It is the intention of the applicant to operate this turbine wheel with compressed air.

1035.19. T. Zweigbengk. Improvements in or relating to electric-motor control systems. 15.12.19.

This application is for improvements in or relating to electric motor control systems, and is a development of a previous application.

1060.19. A. H. Jones. Improvements in ore separating device. 20.12.19.

This application relates to a flotation apparatus comprising an outer conical casing with an open top; an inner conical casing arranged that its wall provides an interspace between this and the outer casing: a central cylinder, open at the bottom to communicate with said interspace, but closed to the inner casing and terminating above the upper surface thereof; the said inner casing to have an inclined upper surface comprising a porous medium together with means for admission of ore pulp to said interspace, propulsion and agitation through said inner cylinder, admission of compressed air to interior of said inner casing, controlled discharge of gangue from said interspace, and collection of overflow from the outer casing.

In action the ore pulp and oil is fed to the interspace, drawn through the central cylinder by the propellor and overflows on to the top of the inner casing, which consisting of a porous medium through which compressed air is passing, effects an intimate pulp aeration, and causes the mineral to rise in the froth thus formed, and pass over the upper annular overflowing, whereas the remainder passes back to the interspace and joins the fresh inflowing pulp for further circulation as may be required.

40.20. International Coal Products Corporation. Improvements in and relating to the manufacture of briquettes. 15.1.20.

This specification describes the manufacture of briquettes from a mixture of coking and non-coking coals with pitch, subsequently carbonising the briquettes to ensure a firm and dense structure with low volatile matter.

81.20. Jackson and Warren. Improvements in valves and cocks. 29.1.20.

This application relates to valves or cocks, more particularly of the kind adapted for use in pressure liquid supply system, such as the ordinary domestic water supply.

In the design which is the subject of this application the ordinary method of forcing a valve on to its seat against the pressure of the liquid being controlled by means of a screwed spindle, is reversed, and an arrangement adopted in which the valve is initially brought into contact with its seat by a spring, and is held there by the combined action of the said spring and the pressure of the liquid.

To permit flow of liquid the valve is pushed off its seat against the load of the spring and the pressure of the liquid by rotation of the usual screwed spindle.

The applicant further proposes to prevent rotation of the valve on its seat.

93.20. United Lead Company. Improvements in hard metal alloys and methods of baking same. 30.1.20.

This application relates to the hardening of lead alloys with alkaline earth metals by the addition of a small amount of mercury for the production of bearing metal.

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